SOCIAL CAPITAL AND ITS RELATIONSHIP WITH HEALTH-RELATED BEHAVIORS IN RURAL UTTAR PRADESH, INDIA

by
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A dissertation submitted to Johns Hopkins University in conformity with the requirements for the degree of Doctor of Philosophy

Baltimore, Maryland
April 2019

Abstract

Social capital has become one of the most contested concepts in the social sciences. This multidimensional concept can be theorized both at the individual and community level. At the individual level, social capital is defined as the embedded resources available through one's social network. And at the community level, it means the characteristics of the social relations within and among groups featured by trust and norms which can be leveraged for coordinated action for collective benefit. While in economics and political science the concept of social capital has a longer history, the role of social capital in global health became more imperative in 2010 after the World Health Organization acknowledged it as a determinant of health and inequity. It is essential to recognize the role of social capital to understand how individuals and communities adopt and sustain health-related norms, acquire information and social support to overcome barriers to health services. Considering social capital as a critical determinant of health, the three papers of this dissertation explored the nuance of measurement of social capital across gender and its relationship with health behavior in the state of Uttar Pradesh (UP), India.

The analysis of these three papers was based on a cross-sectional baseline household survey for a multi-sectoral rural development initiative, known as Project Samuday. The household survey was conducted among 6,218 household heads (≥18years) and all women between 15-49 year of age (n = 6,826) from 6,218 randomly selected households in two rural districts of UP, Hardoi and Sitapur. After receiving verbal informed consent, trained data collectors implemented a multi-module questionnaire designed to collect demographic information, health behavior and social capital of the respondents.

The aim of Paper 1 was to understand the performance of "Shortened Adapted Social Capital Assessment Tool in India" (SASCAT-I), while measuring social capital across gender using a measurement invariance analysis. *Organizational Participation*, *Social Support*, *Trust* and *Social Cohesion* – emerged as four uniquely identified factors of social capital. However, measurement invariance analysis demonstrated the concept of *Organizational Participation* and *Social Support* were

similar across gender, but the perception of *Trust* and *Social Cohesion* were different for men and women. Paper 2 examined the association of individual and community-level social capital with infectious or communicable disease-related preventive care seeking behavior – receiving all three diphtheria–pertussis–tetanus (DPT3) vaccines – among 12-59 month children using multilevel logistic regressions. We found a higher community level *Organizational Participation* and *Social Cohesion* of the mothers were associated with a child's odds of receiving all three DPT vaccines. Whereas, individual mother's *Organizational Participation* was negatively associated with DPT3 vaccination status. Paper 3 explored the role of social capital and social influence on non-communicable disease (NCD) related health behavior – tobacco use – among 6,218 household heads (≥18 years). The social influence of tobacco consumption was measured by "non-self" cluster proportion of tobacco use in the community. The explanatory power of the social capital and social influence on tobacco consumption was assessed using generalized linear (logistic) models with Huber/White/sandwich robust variance estimator. The social influence had a positive and significant association with an individual's tobacco consumption. Beyond the effect of social influence, we also found *Organizational Participation* of individual household heads had an independent and positive association with tobacco consumption.

Contributing to the tradition of establishing measurement invariance of any psychosocial constructs, this dissertation is the first of its kind to addresses the possible measurement bias across gender of SASCAT-I. The findings suggest – the perception of social capital varied across gender specifically for *Trust* and *Social Cohesion*. We found *Organizational Participation* and *Social Cohesion*, had significant relationships with health care-seeking behavior, though they were not always positive. Furthermore, instead of calculating the raw scale score by summing or taking a mean of item scores, factor analysis should be used to analyze data collected by SASCAT-I to account the multidimensionality of social capital. Despite the nuances of definition and measurement, exploration of social capital is particularly important to understand the effectiveness of health system interventions and the capacity of individuals and communities to bring positive changes in their life.

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Acknowledgment

Who not to acknowledge for the accomplishment of this dissertation? – It is an existential question for me. My journey of the doctoral program and completion of the dissertation would not be possible without the support and assistance of many.

First of all, I would like to acknowledge my advisor, Dr. Krishna Rao. Your guidance has been instrumental for me to survive the long haul of the doctoral program. I am immensely grateful for your mentorship which challenged me to think beyond numbers and ground my research into reality. Apart from my advisor, I want to thank Dr. Shivam Gupta humbly. Without his support, none of this would have been possible. I have learned so much from him – either in the class or in the course of the fieldwork or during the long conversations we had about social capital and what that means.

I want to acknowledge all the faculty members who contributed to my dissertation while serving in different committees. My sincerest gratitude goes to Drs. Caitlin Elizabeth Kennedy, Jeannie-Marie Leoutsakos, Lorraine T. Dean, David Peters, David M. Bishai, Saifuddin Ahmed and Marie Diener-West. Your critical insights and thoughtful input enriched my work, and I will always be grateful for your support. Apart from them, I want to thank Drs. Danielle German, Peter Winch, Diwakar Mohan, Ligia Paina and Kerry Scott for providing valuable inputs and reviewing my work in different phases of my dissertation. I would like to thank Drs. David Peters, Courtland Robinson, Abdulgafoor M. Bachani, Maria Merritt and Joanne Katz for the organizational supports and motivations which enabled me to complete my doctoral journey. And a special thanks goes to Cristina Salazar for her administrative support and inspirational words. Your smile always brightened my day!!!

During my fieldwork in India, I received exceptional support from many. I will take this opportunity to express my gratitude to HCL foundation (HCLF) and Project Samuday. Their work on the economic and social development of rural areas of Uttar Pradesh, India is an inspiration for public health. I would like to thank Navpreet Kaur, Alok Varma, Akshay Ahuja, Kunal Saini, and others in the HCLF

team for being a supportive collaborator. To my colleagues whom I met during the Project Samuday – Dr. Arindam Das, Ranjan Kumar Prusty and Samresh Rai – thank you so much for supporting me in the field with your experience and prudence. I am also grateful to Kantar Public, our collaborating data collection agency, and their extraordinary team of researchers and data collectors. And I am forever indebted to all the research participants from Hardoi and Sitapur district of Uttar Pradesh. It is not possible for me to repay the men and women of rural Uttar Pradesh for their time and patience. For their warmth and hospitality, Lucknow and Uttar Pradesh will always be in my heart.

I humbly acknowledge the financial contribution of Fogarty International Training Center (2D43TW007587-06) which supported my education and living during my doctoral training. I express my gratitude to the principal investigators of this grant, Dr. Robert Black and Dr. Abdullah Baqui. Their generous support and guidance cannot be measured by any means. I will also take this opportunity to thank my mentors from the James P. Grant School of Public Health – Drs. Malabika Sarker, Alayne Adams, and Sabina Faiz Rashid. You all helped me to be the researcher I am today. You are my inspirations, and it is my honor have you as my mentors.

To my fellow students of health systems and international health – I thank you from the bottom of my heart to be a part of my journey. I want to thank Douglas Glandon for being a fantastic teammate especially. You are a relentless force of positivity. And a special thanks goes to Dr. Avril Kaplan, my fellow social capital aficionado. Your knowledge and determination always motivated me, and I have learned so much from you.

I would like to thank my family in Bangladesh who always believed in me. Looking back to my life I can't even imagine how much my parents, Dr. Muzaffor Rahman and Dr. Quamrun Nesa, supported me in every step of my life. I missed my two sisters, Mareen Afrin, and Tahrin Afrin, the most during my doctoral program. I am expressing my earnest gratitude to my mother-in-law, Ferdous Alam, for being so supportive for my family and me. To my friends in Bangladesh and across the world – Rockyb Hasan,

Jishan Faisal Chowdhury, Abdullah Nurus Salam Khan, Takvir Ahmed, Reshad Falah Nazim, and Rakib Mahmood – thank you for supporting me through my brightest day or darkest night. You were always there for me just a phone call away.

To Tasmeer Alam, my beloved wife – you took my hand and jumped with me into this journey without asking any question. Your support cannot be expressed in mere words. You believed in me, gave me the strength – even when I doubted myself. It was only for your sacrifice which allowed me to finish my study. I am dedicating my dissertation to you.

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1. Introduction

1.1 Social capital and its constructs

Theorization and research on social capital gained its traction in the field of public health from the late 1990s (Kawachi, Subramanian, & Kim, 2008). Though in the other genres such as sociology (Bourdieu, 1986a; Coleman, 1988), political science (Putnam, 1995, 2000) and economics (Helliwell & Putnam, 1995; Knack & Keefer, 1997; Loury, 1992) the definition and role of social capital were debated from much earlier. Among the sociologist, Pierre Bourdieu (1986b) initially gave a concise definition of social capital.

> *"Social capital is the aggregate of the actual or potential resources which are linked to possession of a durable network… [it] provides each of its members with the backing of the collectively-owned capita"* (Page 48-49)

Defining the "*durable"* network of people as a social structure, American sociologist James Samuel Coleman (1988) explained social capital, not as a single entity but as a hybrid construct which function is to generate social credit. According to Coleman:

> *"Social capital is defined by its function. It is not a single entity, but a variety of different entities with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors… Like other forms of capital, social capital is productive…Unlike other forms of capital, social capital inheres in the structure of relations between actors and among actors."* (Coleman, 1988), p. S98).

While Coleman conceptualized social capital as a multi-dimensional construct, in his seminal work *"Bowling alone: America's declining social capital"* Robert Putnam explained different constructs of social capital as-

> "*features of social organization, such as trust, norms, and networks, that can improve the efficiency of society by facilitating coordinated actions*" (Putnam, 1995, page 167).

Putnam's definition brings a communitarian perspective into the definition of social capital. According to him social capital works within the broader umbrella of the community and diffuse through the locality like a "*Social Miasma*." It is a very different take on explaining how social capital works as an "*actual or potential resources*" within human connections. Kawachi (2008) described these two genres of

social capital conceptualization as “network” perspective (Bourdieu, 1986a; Lin, Cook, & Burt, 2001) and social cohesion perspective (Coleman, 1988; Putnam, 1995). To reconcile this dichotomy, researchers in late 1990s and early 2000 proposed two different components of social capital: Structural and Cognitive (Bain & Hicks, 1998; Harpham, Grant, & Thomas, 2002; Krishna & Shrader, 2000b).

The structural component of the social capital reflects the associational link of people, its functions, and outputs of those relationships. These functions are presented by group membership and collective action. And most of the time the outcome is social support from formal or informal groups (Harpham, 2008). In 2004, Szreter & Woolcock proposed bridging, bonding and linking social capital which also reflects the structural form of social capital. This classification is based on the differential level of social ties that exists in the community (Gittell & Videl, 2017; Kawachi, 2006). Bonding and bridging together represent horizontal social capital which develops among individual or groups who are “near-equals” who do not have any difference in power or social hierarchy (Islam, Merlo, Kawachi, Lindström, & Gerdtham, 2006). While Szreter & Woolcock (2004) suggested linking as a subcomponent of bridging social capital, Islam et al. (2006) conceptualized this as a separate entity. The resources embedded on the social ties which transcend the socio-economic-cultural boundary of a community and link people with different level of power, authority or resources are defines as linking social capital. Bridging and linking social capital are associated with dissemination of novel ideas, instrumental and financial support; and political and civic engagement (Cullen & Whiteford, 2001; Mitchell & LaGory, 2002; Story, 2014; Varshney, 2003). Moreover, bonding social capital is responsible for channeling behavioral norm, cultural practices, and emotional, informational and appraisal social support (Cullen & Whiteford, 2001; Story, 2014).

Lastly, cognitive, social capital embodies more subjective constructs such as trust, social cohesion, and reciprocity. Trust is a vital component of social capital, and some researchers argue that it is the precursor of social capital (Harpham, 2008). Social cohesion is interpreted by social harmony, solidarity and a sense of belongingness in the community which is the cornerstone of Putnam's (1995) definition of social capital. Reciprocity represents the “two-way” willingness to provide social support to others with a

preconceived belief of getting support in return in the future (Ashrafi, Montazeri, Mousavi, Vaez-Mahdavi, & Asadi-Lari, 2012; Harpham, 2008; Harpham, De Silva, & Tuan, 2006; Mitchell & Bossert, 2007)

1.2 Social capital, health and health seeking

The relationship between social capital and health or healthcare utilization is complex (Kawachi, Takao, & Subramanian, 2013). In every context, the characteristics of social relationships are unique, hence the nature of social capital of the individual and community. The structural form of social capital can be represented by participation in formal or informal social groups within the community. This allows the dissemination of information and innovation within the network which can lead to both positive or negative health outcomes. Women's self-help groups in India is an ideal example of structural social capital at work. By formalizing social network among lower socio-economic group women, self-help groups improved the maternal and child health of its participants (Saha, Annear, & Pathak, 2013). Another way structural social capital influence an individual's or group's health-related behavior is through the "*actual and potential*" resources embedded in their network (Kawachi et al., 2008). These resources can be used to acquire instrumental support for healthcare utilization (such as cash, transportation, etc.). A person can also invest in his or her social network with an intention to build reciprocity. In the time of need – such as illness – this "credit slip" helps to buffer the stress with returning social support from the community.

The function of trust as the cognitive component of social capital is somewhat nuanced. Particularized trust (trust in familiar persons - such as the family, neighbor, community health workers) allows an individual to access social support and enable to perform collective action. This can lead to creating an enabling environment for everyone to access and utilize healthcare readily (Bisung, Elliott, Schuster-Wallace, Karanja, & Bernard, 2014). On the other hand, generalized trust (trust on strangers - such as healthcare provider or community as a whole) helps to create bridging social connection or access to new information or health services (Glanville & Story, 2018).

Social cohesion can influence health-seeking behavior both at the individual and community level. An individual with a higher perception of cohesiveness with the community often tries to align with the social norms. And if the social norm is speculative towards any treatment or health service, people may not be willing to use them despite having the knowledge or access to the service. At the collective level, social cohesion enables the community to impose informal social control to establish social norms among its members (Seid, Hesse, & Bloomfield, 2015). Thus any health behavior – either negative or positive –established as social norm often gets adopted by an individual or the community. Mohnen and colleagues (2012) identified smoking and substance abuse, sleeping patterns, physical activity and dietary habits as health behavior which are often influenced by social capital. If immunizing children is identified as a social norm, member of a highly cohesive community will support each other to remove any barrier to the immunization service. On the other hand, members of the anti-vaccine campaigns also demonstrate a higher level of cohesiveness due to their shared belief system (Mitra, Counts, & Pennebaker, 2016).

1.4 Organization of this dissertation

This dissertation is organized into three independent papers connected with the thread of social capital and its relationship with health-related behavior and care seeking practice. While the measurement of social capital has been a key focus of sociologists since the 1980s, there is very little evidence regarding the performance of any quantitative tool when measuring social capital for men and women. Filling this critical gap in the literature the first paper used a factor analytic framework to explore the factor structure of social capital and measurement invariance across gender. This is the first study to use measurement invariance analysis across multiple groups to statistically explore the difference of the latent measures of social capital constructs.

The second paper explores the association of social capital with a critical infectious disease-related health indicator for children - receiving all three doses of diphtheria–pertussis–tetanus (DPT3) immunization before the age of 12 months. Beyond the preference of the parents or the performance of the health system, failure to vaccinate children with DPT3 can be associated with contextual factors of a

community – such as the organization of the social structure, existing social norms, and social capital, etc. Within the premise of this paper, we explored the role of social capital on DPT3 immunization among 12-59 month of children using a multilevel analytical framework. Though this is the second study which explored the relationship between social capital and immunization in India, our study was the first to incorporate individual and community level social capital measures of both mothers and the household heads in the analysis.

Exploring the other spectrum of disease etiology, the primary objective of the final paper was to understand the association of social capital with one of the most common NCD-related health behavior – tobacco consumption. The secondary objective was to investigate the role of social influence (tobacco use at the community level) on an individual's likelihood of tobacco consumption above and beyond the effect of social capital. This is the first study which used an integrated framework of social cognitive and social capital theory to explore these relationships.

2. Study Context

2.1 State Context

Situated in the northern region, Uttar Pradesh (UP) is one of the most populous states of India (Figure 2.1). Surrounded by Rajasthan to the west; Haryana and Himachal Pradesh to the north; Bihar from the east, Madhya Pradesh to the south and Nepal to the north UP is the home of around 220 million people. Similar to the other parts of India, UP is currently experiencing exponential growth in the economy and information technology sector (USAID & K4Health, 2010). While India also demonstrated substantial achievement in increasing life expectancy, improved literacy rate and living condition for their people, considerable disparities exist in UP based on geographical, gender, socio-economic and educational status (International Institute for Population Sciences & ICF, 2017). These inequalities are more significant in the rural districts of UP – such as Hardoi and Sitapur – which are the geographic focus of this study (Table 2.1).

Figure 2.1: Map of UP indicating the study site (Hardoi and Sitapur districts)

Table 2.1: Demographic and health indicators of UP and the study sites

Indicators	Hardoi	Sitapur	Uttar Pradesh	National
Population [1]	4,092,845	4,483,992	199,812,341	1,210,854,977
Proportion of Under 15 Population (%)	36.4	35.7	33.8%	28.6
Sex Ratio (per 1,000 male)	945	912	995	991
Household with electricity (%)	42.2	29.9	70.9	88.2
Household with improved sanitary facility (%)	28.3	16.7	35.0	48.4
Literacy Rate (Male: Female, %)				
Male (%)	73.3	72.6	82.4	85.7
(Female, %)	54.2	50.6	61.0	68.4
Total fertility rate (children per woman)	--	--	2.7	2.2
Use of any Family Planning Methods (%) [a]	26.4	42.8	45.5	53.5
Unmet Need for Family Planning (%) [a b]	25.6	17.5	18.1	12.9
Mothers who had at least 4 antenatal care visits (%)	10.3	10.2	64	51.2
Institutional Births (%)	65.4	67.8	67.8	78.9
Infant mortality rate (per 1,000 live births)	--	--	64	41
Under-five mortality rate (per 1,000 live births)	--	--	78	50
Full immunization among 12-23 months (%)	39.1	44.8	51.1	62.0
DPT-3 immunization among 12-23 months (%)	56.8	54.5	66.5	78.4
Children under age 6 months exclusively breastfed (%)	51.3	62.7	41.6	54.9
Proportion of Under 5 children stunted (%)	50.5	56.4	46.3	38.4
Proportion of Under 5 children wasted (%)	14.7	14.0	17.9	21.0
HH with any member with health scheme (%)	2.8	8.1	6.1	28.7
Tobacco consumption among adults (%) [2]	--	--	35.5	28.6
Male (%)	--	--	52.1	42.4
Female (%)	--	--	17.7	14.2

Data: International Institute for Population Sciences, & Ministry of Health and Family Welfare. (2016). National Family Health Survey Final Report: Uttar Pradesh. Retrieved from http://rchiips.org/NFHS/NFHS-4Report.shtml
1 = Office of the Registrar General & Census Commissioner. (2011). States Census 2011. Retrieved December 13, 2017, from http://www.census2011.co.in/states.php
2 = Ministry of Health and Family Welfare, Government of India, & Tata Institute of Social Sciences. (2017). Global Adult Tobacco Survey India 2016-17. (p. 4). Retrieved from https://mohfw.gov.in/sites/default/files/GlobaltobacoJune2018.pdf

Note: a = Among currently married women age 15–49 years
b = Unmet need for family planning refers to fecund women who are not using contraception but who wish to postpone the next birth (spacing) or stop childbearing altogether (limiting)

Being one of the largest states of India the socio-cultural and health system of UP has been widely studied by public health and social science researchers (Awasthi & Shrivastav, 2017; Banu & Rawal, 2017; Bardhan, 1974; Dettrick, Jimenez-Soto, & Hodge, 2014; Goli & Arokiasamy, 2014; Kowal & Afshar, 2015, 2015; Saroha, Altarac, & Sibley, 2008; Seth et al., 2017; Sridharan et al., 2017; Srivatsan, 2015; Sultana, 2017; Vart, Jaglan, & Shafique, 2015). However, there is limited information regarding regional- and state-level social capital in India. According to the Global Prosperity Index, India ranked 82nd on the social capital in the world (Legatum Institute, 2017). Though previous studies

measured social capital in other states of India – such as Andhra Pradesh, Nagaland and Tamil Nadu (Kaplan, Rao, Mullen, & Bhatnagar, 2018; Palanisamy, Gopichandran, & Kosalram, 2018; Silva & Harpham, 2007) – only a few studies explored social capital in the context of rural UP. Thus, the nuances of measurement and the nature of social capital in rural UP are not well understood. This situation presents a unique opportunity to explore the structure of social capital and its contribution to the everyday life of the rural people of UP.

2.2 Healthcare system in UP, India

The history of traditional medicine goes back centuries in India. However, the current health system was conceptualized after the report of the Bhore Committee in 1946 (Ma & Sood, 2008; "Summary of the main recommendations of the Bhore committee," 1979). Based on their recommendation, a three-tiered preventive and curative care system was founded by the Central and State Governments (National Health Mission, 2017). As the first level of primary health care, UP has 20,521 Subcenters. In each facility, one female Auxiliary Nurse Midwife (ANM) and one male health worker provide care related to maternal and child, nutrition, immunization, communicable diseases to 5000 population. Next, 3,621 Primary Health Centers (PHC) act as a referral unit of 5-6 subcenters and provide care to each 30,000 population. PHC has both inpatient and outpatient facilities and provides promotive, preventive and curative cares by thirteen personnel which includes one medical doctor, three staff nurses and other additional staffs (health assistant, lady health visitor, and laboratory technicians). Directly above PHC, 822 Community Health Centers (CHC) are the third-tier facility and manned by four medical doctors and an additional 21 supporting staffs serving 120,000 population. In addition to regular outpatient service, each CHC has indoor service with 30 beds, operation theaters, radiology, and laboratory diagnostics facility. Finally, district hospitals and sub-divisional hospitals are considered as fully functioning first referral unit (FRU) (National Health Mission, 2017).

To support the primary care system female Accredited Social Health Activist (ASHA) provides domiciliary maternal and child care, nutrition and immunization services for nearly 1000 population in a

village and supervised by the ANM of the local subcenter (Ministry of Health and Family Welfare, 2005). Anganwadi Workers (AWW), a frontline nutritional care provider, serves the same 1000 population. While the cadre of ASHA was introduced in 2005, AWWs were serving rural UP since 1975 under Integrated Child Development Services (ICDS) Policy (Ministry of Women and Child Development, 2017). Together ASHA, AWW and ANM (informally known as AAA) work within a collaborative framework (Ministry of Health and Family Welfare, 2017) with the support of Village Health and Sanitation Committees (VHSNC) in each Gram Panchayat (Ministry of Health and Family Welfare, 2006a). Gram Panchayat is a democratically elected and constitutionally accredited committee which acts as the governing body of the rural communitarian society of India (Ministry of Panchayati Raj & Government of India, 2017). National Health Mission (NHM) leveraged this existing local government structure to create VHSNC by integrating community leaders, representative of local women's Self-help Group, ASHA, AWW and other community-based organizations (Ministry of Health and Family Welfare, 2005). VHSNCs act as an interface between community and health system to implement government programs and facilitate community health workers (Ministry of Health and Family Welfare, 2006b). While NHM provided a guideline for the VHSNCs to function, power dynamics and socio-cultural composition of the community often led to the exclusion of lower caste and religious minorities from VHSNC (Kumar, Mishra, & Verma, 2016; Scott et al., 2017). It has significant implications for essential services as Immunization, maternal and child care and nutritional programs (Scott, George, Harvey, Mondal, Patel, Ved, et al., 2017).

Moreover, an emerging private sector is transforming India's health market into a mixed healthcare system (Sheikh, Saligram, & Hort, 2015). In private healthcare market, medically trained private providers and unqualified informal providers (jhola chapp, quacks, pharmacy) deliver a differential quality of service (Patel et al., 2015; Peters et al., 2002; Raza, Van de Poel, Panda, Dror, & Bedi, 2015). This was one of the impetus of formulation of National Health Policy'17 (Ministry of Health

& Family Welfare, 2017) and NITI Aayog (Government of India, 2017) which envisions a stronger health system with intersectoral collaboration.

2.3 Health status and health seeking in India and UP

UP is one of the weak performers on human development and health indicator while having a pluralistic health system (Appendix 1). At the national level, the total fertility rate is 2.2 children/women, and in UP it is 2.7 children/women. Only 45.5% of the currently married women ages 15-45 year use any contraceptive method, 26.4% have ≥4 ANC visits, and only 67.8% have institutional delivery (Table 2.1). This results in a higher infant and neonatal mortality, almost 1.5 times greater than the national average (International Institute for Population Sciences & ICF, 2017).

The lower service utilization is evident for both preventive and curative care. While looking into the health indicators for children, there is a secular trend of increasing immunization coverage in UP (Bhatnagar et al., 2016; Weiss, Choudhary, & Solomon, 2013). However, currently, only 51% of children receive full immunization at the end of their second year of life. Only two third of the children with diarrhea were taken to any health facility, only one-third of them received oral rehydration therapy, and 12.6% received zinc. Among the under-5 children, around half are stunted, and 18% are wasted. For all of the nutritional and health indicators, rural areas are overburdened compared to their urban counterpart (International Institute for Population Sciences & ICF, 2017).

Though the utilization of care is low, the majority of people overwhelmingly use private care providers. Around 86% of all the acute illness events and 70% of the hospitalization were being treated in private facilities. This is due to physical accessibility, absenteeism of healthcare providers, dearth of proper infrastructure and supplies, lack of monitoring and supervision; and insufficient inter-sectoral coordination in public facilities (Bajpai, Sachs, & Dholakia, 2010; Sridhar, Maleq, Guillermet, Colombini, & Gessner, 2014; Vashishtha & Kumar, 2013). Thus, private and informal care provider filled this gap dispensing care with a differential level of quality. In general, the poor rural households of UP

access un-qualified allopathic providers or traditional healers practicing AYUSH (R. Kumar, Jaiswal, Tripathi, Kumar, & Idris, 2007; May, Roth, & Panda, 2014; Raza et al., 2015; Rohde & Viswanathan, 1994). On the other hand, in the urban area care seeking is more prevalent to private providers and non-government drug dispensers (pharmacies) for acute illness events (Srivastava, Awasthi, & Agarwal, 2009).

A growing trend of non-communicable disease prevalence indicates UP is currently going through the initial phase of epidemiological transition. The latest National Family Health Survey (NFHS) of 2015 showed 16.5% men and 12.5% women in UP were either overweight or obese compared to 9.2% and 7.3% reported in 2015's NFHS (International Institute for Population Sciences & ICF, 2017). In addition, UP has one of the highest prevalence of tobacco use. Currently, more than 35% of the adult consumes any type of tobacco product, and the rate is astonishingly high among men (Men = 52.1%, Women 17.7%) (Ministry of Health and Family Welfare, Government of India & Tata Institute of Social Sciences, 2017).

Health disparities are also inflated due to factors from the demand sides. Social-cultural factors (such as socioeconomic status, religion, caste diversity, education) and knowledge, trust and social norms play critical role in health service use (Dumont, 1980; Gupta, Prakash, & Srivastava, 2015; Pandey, Sehgal, Riboud, Levine, & Goyal, 2007; Story, 2014; Vallabhaneni, 2015; Vart et al., 2015; Weiss et al., 2013). Groups belong to the lower caste category – scheduled caste, scheduled tribe, and other backward castes – face significant economic, social, educational and health disparities (Office of the Registrar General & Census Commissioner, 2011). An additional layer of complexity emerges when we consider the role of gender in the health seeking process. Girls and women are often neglected while making their own decision for their health and reproductive choice (Fikree & Pasha, 2004; Sinha, Peters, & Bollinger, 2009; Stroope, 2015).

3. Exploration of factor structure and measurement invariance by gender for a modified adapted social capital assessment tool (SASCAT-I) in rural Uttar Pradesh, India

Abstract

Social capital is defined as the nature of the social relationship between individuals or groups and the embedded resources available through the social network. While it is considered as a determinant of health and wellbeing, it is also affected by gender, ethnicity, class, etc. Yet, there is no evidence on how quantitative tools perform when measuring social capital across gender. Using measurement invariance analysis, this paper explored the factor structure of the social capital of men and women measured by a modified Shortened Adapted Social Capital Assessment Tool (SASCAT-I) in two districts of UP, India.

Adapted from SASCAT, using rapid cognitive interviewing, the SASCAT-I was developed to measure self-reported social capital. The study sample comprised 5,287 men (≥18 years) and 7,186 women (15-45 years) from 6,218 randomly selected households who responded to SASCAT-I during a community-level cross-sectional survey. Social capital factor structure was examined by both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) and measurement invariance across gender was investigated using multi-group CFA.

The result supported a partial metric-invariance indicating – factor pattern and loadings for *Organizational Participation* and *Social Support* were invariant, while *Trust* and *Social Cohesion* were not equivalent across gender. Gender-stratified CFA demonstrated the same four-factor solution had an adequate model fit for men, whereas a three-factor solution (*Organizational Participation*, *Social Support,* and an overall *Cognitive Factor*) was the most parsimonious and best-fitted for women.

Self-reported SASCAT-I presented a multidimensional measure of social capital. The result also indicated the perception of *Trust* and *Social Cohesion* varied across gender. For any future applications, we recommend adapting the tool to the unique research environment. Furthermore, instead of calculating the raw scale score by summing or taking a mean of item scores, factor analysis should be used to analyze data collected by SASCAT-I.

3.1 Introduction

Social capital has become one of the most contested concepts in the social sciences over the last few decades since Robert Putnam's (1995) groundbreaking work on democracy and civic engagement. The role of social capital in global health became more imperative in 2010 after the World Health Organization's Commission for Social Determinants of Health acknowledged social capital as a crosscutting determinant of health and inequity.

Sociologist Pierre Bourdieu (1986) first gave a concise definition of social capital – *"…the aggregate of the actual or potential resources which are linked to possession of a durable network… [it] provides each of its members with the backing of the collectively-owned capital"* (p. 48-49). However, Robert Putnam in his seminal work "Bowling alone: America's declining social capital" took a drastic departure from Bourdieu's network-based resource definition. According to Putnam, social capital is the characteristic of any social organization (such as trust, civic engagement, cohesion, reciprocity, etc.) which facilitates coordinated action (Putnam, 1993, 1995). Tieing together the individual and socio-structural definition of social capital, American sociologist James Coleman theorized social capital as a multifaceted construct. According to him,

> "*It is not a single entity… with two elements in common: they all consist of some aspect of social structures, and they facilitate certain actions of actors… social capital inheres in the structure of relations between actors and among actors.*" (Coleman, 1988, p. 98).

This multidimensional conceptualization gave rise to the operationalization of several subconstructs of social capital to understand its complexity. Social capital is generally classified into structural and cognitive components. Structural social capital characterized individuals and their social network indicating "*objective measures of what people do*" (Islam et al., 2006). It features characteristics such as group membership, social support, collaboration, and political engagement. Cognitive social capital symbolizes how people "*feel*" as reflected by social norm, trust in the community, belongingness, and reciprocity (DeSilva & Harpham, 2007). However, in 2004, Szreter & Woolcock proposed bonding,

bridging and linking social capital as another dimension of social capital based on group composition. Bonding social capital develops among individuals of a group who have a similar social identity (Islam et al., 2006). Bridging social capital represents the relationship between individuals with somewhat different social characteristics (such as class, religion, ethnicity) with similar social hierarchy and power. And, linking social capital develops within the hierarchical network of individuals with a differential level of resources and power (Szreter & Woolcock, 2004; Varshney, 2003).

The relationships between the latent construct of social capital and health and health-seeking behavior are explored extensively in the literature in the context of low- and middle-income countries (LMIC) (Agampodi, Agampodi, Glozier, & Siribaddana, 2015; Kawachi et al., 2008; Story, 2013). However, the association between social capital and health is very nuanced as social capital is formed in the context of complex social relationships that depend on individual and group identities, such as gender, ethnicity, culture, etc. (World Health Organization, 2010).

3.1.1 Social capital and gender

Whether considering the structural or cognitive component, social capital may vary by gender due to differences in the social networks of men and women, which have been reported in the literature. First, social networks of women are more likely to feature kin and neighbors, while men's networks are more likely to feature friends, coworkers and advisors (Burt, 1998; Kim, 2014; Moore, 1990). Even though men and women have a similar number of organizational memberships, Chua et al. (2016) observed that traditionally women were more affiliated with domestic life, religion and community affairs. On the other hand, men's organizational membership tends to be more economically oriented (Chua et al., 2016; O'Neill & Gidengil, 2013). These differences in structural social capital, in turn, help women to build bonding social capital and among men bridging and linking social capital.

The difference in cognitive social capital across gender is more nuanced and based on the culture. Traditionally, the patriarchal nature of Indian society – specifically Northern India – reinforced an

inegalitarian culture for women (Rajadhyaksha & Velgach, 2015). From childhood to adulthood, men and women were often socialized into the prescribed categories of masculinity and femininity (Chua et al., 2016). Exploring the social role of women, Ridgeway (2011) explained women are generally perceived to be caring and communal in nature and men as more agentic and strategic. These social roles may affect how men and women perceived the cognitive aspects of social capital, such as trust and cohesiveness (Cross & Markus, 1993).

The effect of gender on the relationships between social capital and life satisfaction, well-being, economic activity, or health are well explored in literature (Chua et al., 2016; Chuang & Chuang, 2008; Kavanagh, Bentley, Turrell, Broom, & Subramanian, 2006; Kim, 2014; Leeves & Herbert, 2014; Locher et al., 2005; Lu, Jiang, Lou, Zeng, & Liu, 2018; Westermann, Ashby, & Pretty, 2005). However, there is little evidence of how the wide range of quantitative tools used in these studies performed when measuring social capital across gender. The difference in the performance of a tool to measure social capital across gender may have a multifaceted impact on research by affecting the decision of – whom to include as respondents, when to collect data, who collects the data and how to analyze the data (Morgan et al., 2016). All these may bias the finding of health systems research and leading to gender inequality in health policy and interventions (Guenole & Brown, 2014; Millsap & Kwok, 2004).

3.1.2 The present study in Uttar Pradesh, India

Historically, caste and social hierarchy have been entrenched in everyday individual and community life in India, more specifically in UP (Kowal & Afshar, 2015). Power, gender dynamics and socioeconomic composition often led to the exclusion of women, lower castes and religious minorities from decision-making in the rural community (Kumar et al., 2016; Scott, George, Harvey, Mondal, Patel, Ved, et al., 2017). While investigating the role of Gram Panchayat as a grassroots level democratic institution, Sudha Pai (2001) explored the implication of the deep-seated social segmentation on the social capital of rural UP. She highlighted the contextual effect of gender and caste/class divisions in the rural society of UP which determines the development of social capital within and between groups. Other

studies also observed a substantial difference in civic engagement and group participation – as a proxy of social capital – due to gender, caste and class difference (Hans, 2014; Lise, 2000; Mayer, 2001). Given the role of social capital as an accepted determinant of health (World Health Organization, 2010), its structure in UP is not well understood. This presents a unique opportunity to investigate the social capital of men and women, living in rural UP. This study aimed to examine – how did a short and simple quantitative social capital tool perform during the measurement of social capital across gender? We hypothesize that the factor structure of social capital will differ for men and women. To answer this question, we used the factor analytic framework to explore the factor structure of social capital and measurement invariance across gender measured by the modified Shortened Adapted Social Capital Assessment Tool in India (SASCAT-I) in rural UP, India.

3.2 Method

3.2.1 Data source

The analysis is based on the baseline household survey for a multi-sectoral rural development initiative by HCL Foundation (2018) known as Project Samuday. The survey was conducted from June to August 2017 in two rural districts of UP, Hardoi, and Sitapur. Adjacent to Lucknow, the capital of UP, both districts are considered to be rural and performing poorly on critical demographic, economic and health indicators (International Institute for Population Sciences & ICF, 2017).

Adopting a multistaged cross-sectional design the survey was conducted among 6,218 randomly selected households from 346 Gram Panchayats. Each Gram Panchayat (GP) consists of one to four villages and is constitutionally accredited as the rural governing body (Ministry of Panchayati Raj & Government of India, 2017). Within each GP, the Government of India has assigned one community health worker called the Accredited Social Health Activist (ASHA) to serve a thousand population (Government of India, 2018). During the survey, one ASHA's service area was randomly selected from each GP to be the primary sampling unit (PSU), and 17-18 households were randomly selected for interviews from each PSU. After receiving verbal informed consent, trained data collectors interviewed the household heads (≥18 years of age) and all women between the ages of 15-49 in the household. The survey instrument included information related to social capital and socio-demographic characteristics. From each PSU, on average 15 men and 20.8 women responded to SASCAT-I. The analytic sample of the study included 5,287 men (85% of the household heads) and 7,186 women with a response rate of over 99%. Ethical approval for this study was received from the Institutional Review Board Office of Johns Hopkins Bloomberg School of Public Health and locally from Center for Media Studies, New Delhi, India.

3.2.2 Measures

Social capital

A quantitative exploration of social capital within any community-based survey often requires a relatively short measurement instrument. Advancing the earlier work of the World Bank (Krishna & Shrader, 2000a), Harpham and colleagues (2002) developed an Adapted Social Capital Assessment Tool (ASCAT). This tool measures explicitly individual social capital in the context of low- and middle-income countries. Based on the work of Harpham, De Silva et al. (2006, 2007) developed and implemented SASCAT in the Young Lives Research Project on childhood poverty in Peru, Ethiopia, Vietnam, and India after performing psychometric and cognitive validation. Since 2016 additional research also has been performed to improve the validity of an updated version of SASCAT (SASCAT-B) in the context of Bangladesh (Story, Taleb, Ahasan, & Ali, 2015a).

In this study, initial social capital questions were developed in English from SASCAT (De Silva et al., 2006) and SASCAT-B (Story et al., 2015a). To translate the questions into Hindi, a bilingual panel of researchers performed two rounds of rapid cognitive interviews and incorporated appropriate local colloquialism, idioms and vernacular terms (Beatty & Willis, 2007; Haeger, Lambert, Kinzie, & Gieser, 2012). The final and contextually modified SASCAT-I was back-translated into English to check the translational validity of the questions (See Appendix 2 for details). To assess the factor structure of social capital, 12 items were generated from 13 self-reported questions of SASCAT-I (Table 3.1). The first seven questions of the tool are related to structural social capital: group membership (2 questions), collective action (2 questions), and social support (3 questions). The last six questions are related to cognitive social capital: trust (3 questions) and social cohesion (3 questions).

Table 3.1: Social capital indicators generated from SASCAT-I in UP, India

Social Capital Indicators		
Structural Social Capital Indicators: Binary Responses (Yes = 1, No = 0)		
GM	*group membership* [a]	In the last 12 months, participated in or received any benefit from any community group
CA	*collective action*	In the last 12 months, worked together with other community members and attempted to address a problem or common issue of the village
DD	*development discussion*	In the past 12 months, spoke with anyone about the development of the village
ES	*emotional support*	In the last 12 months, received any emotional social support
FS	*financial support*	In the last 12 months, received any financial social support
IS	*informational support*	In the last 12 months, received any informational social support
Cognitive Social Capital Indicators: 3 Point Likert Responses (Yes = 2, Sometime = 1, No = 0)		
TL	*trust in leaders*	Overall, trust in village leaders
TS	*trust in strangers*	Overall, trust in unfamiliar people residing in the village
TN	*trust in neighbors*	Overall, trust in village neighbors
SH	*social harmony*	People in this village generally have good relationships with each other
SB	*sense of belonging*	Feel that you belong to this village
SF	*sense of fairness* [b]	People in this village would try to take advantage of you if they get the chance

Note: a = Group Membership indicator is generated by merging two items, Group participation and received benefit
b = Sense of Fairness is reversely coded (Yes = 0, Sometime = 1, No = 2)

Group membership included (1) *"In the last 12 months, have you been a member of any of the following groups?"* and (2) *"In the last 12 months, how have you participated in or benefited from the group?"*. However, these two items were merged into one (called group membership) due to high linear dependency (correlation coefficient 0.98). Collective action was elicited by (1) *"In the last 12 months, have you worked together with other community members and attempted to address a problem or common issue of the village?"* and (2) *"In the past 12 months, have you spoken with anyone about the development of your village?"*. Three separate items were used to understand the number of sources from where emotional, financial and informational social supports were received within the last 12 months. These six items were recategorized into dichotomized (yes/no) responses for analysis. Trust in village leaders, strangers (any unfamiliar people residing in the village) and neighbors were measured by three separate items. Social cohesion was measured by three items: (1) social harmony - *"Do you think the majority of people in this village generally have good relationships with each other?"* (2) sense of belonging- *"Do you feel that you have a sense of belonging to this village?"* and (3) sense of fairness- *"Do you think that the majority of people in your village would try to take advantage of you if they got the*

chance?" Items related to the six cognitive social capital were framed as a 3-point Likert scale (yes, sometimes and no).

3.2.3 Data analysis

Data management, descriptive analysis, and Horn's parallel analysis were conducted using Stata version 15 (StataCorp, 2017). Bivariate association of social capital items and gender were assessed using the chi-square test. Factor analytical framework was used to explore the factor structure of social capital (Elgar et al., 2011; Stafford, De Silva, Stansfeld, & Marmot, 2008) and multiple-group confirmatory factor analysis was used to assess measurement invariance across gender (Chavez, Shrout, García, Forno, & Celedón, 2018; J. Kim & Kamphaus, 2018). All exploratory and confirmatory factor analysis were performed using Mplus version 8.1 (Muthén & Muthén, 2017).

Analytic strategy

Measurement invariance (also known as factorial invariance analysis) is used to quantitatively assess if the factor structure of latent variables (such as social capital) are the same across groups of the population. In the context of this study, before assessing the measurement invariance across gender, it is necessary to understand the possible factor structure of social capital measured by the SASCAT-I in the total sample. It is recommended to fit simpler models based on the theoretical framework to assess the factor structure at the first stage (Dedrick & Greenbaum, 2011). First, a series of factor analytical models were implemented disregarding gender. The sample was divided randomly into two equal subsets while considering the gender of the respondents. Subset one (n = 6,207) was used to perform the Exploratory Factor Analysis (EFA). Then, Confirmatory Factor Analysis (CFA) was performed using the second subset (n = 6,266) to assess the generalizability of the possible factor structure (Huang & Cornell, 2015). Next, we evaluated measurement invariance across gender using multiple-group CFA suggested by Gregorich (2007).

Measurement invariance analysis of the factor structure of social capital requires exploration of five types of hierarchical factorial invariance across the sample of men and women – including dimensional, configural, metric (also known as the pattern), scalar and uniqueness factorial invariance. To achieve dimensional invariance, the SASCAT-I needs to present the same number of common factors across gender. This was assessed by performing Horn's (1965) parallel analysis independently among the total sample of men (n= 5,287) and women (n = 7,186). Conditional on dimensional invariance, a multiple-group CFA model was implemented to test the hypothesis of configural invariance. If each common factor across gender is associated with the same set of items and the CFA model indicates an adequate model fit, configural invariance is accepted. However, configural invariance is not enough to quantitatively compare the factor structure between groups. If configural invariance is achieved, equality constraints on the factor loadings of corresponding items are imposed to perform metric invariance analysis. This would indicate that the common factors across gender have the same meaning.

$$Men: y_m = \tau_m + \lambda_m \eta + \varepsilon_m \quad (1)$$

$$Women: y_w = \tau_w + \lambda_w \eta + \varepsilon_w \quad (2)$$

Here, y_m and y_w are the response vector of n number of observed indicators from each man and woman respondent accordingly. Similarly, on the right side of the equation, τ_m and τ_w are the vectors of intercepts, λ_m and λ_w are the vectors of the loadings for common factor η, and ε_m and ε_w are the measurement errors or residuals for the items. Considering $\lambda_m = \lambda_w$ for each of the twelve items, metric invariance is achieved if these equality restrictions do not significantly reduce the fit compared to the configural model. Moving forward, scaler and uniqueness invariances were sequentially assessed by considering the intercepts ($\tau_m = \tau_w$) and the residuals ($\varepsilon_m = \varepsilon_w$) to be the same across gender respectively while comparing the goodness of fit of the models.

Based on the result of the measurement invariance analysis, social capital factor structures for men and women were separately re-estimated using EFA, and the generalizability of their factor structures was assessed using CFA. All factor analytical models were estimated using “Weighted Least

Square Mean and Variance" (WLSMV) adjusted estimator using polychoric correlation matrix and holding factor variances fixed to one. Overall fit of the models were considered to be adequate if both comparative fit index (CFI) and Tucker-Lewis index (TLI) were ≥ 0.90, standardized root mean square residual (SRMR) was < 0.08 and root mean square error of approximation (RMSEA) was < 0.07 (Cheung & Rensvold, 2002; Hooper, Coughlan, & Mullen, 2008; Prudon, 2014). Any nested model was considered to have a better fit by achieving a non-significant Satorra-Bentler scaled chi-square difference test (Asparouhov & Muthen, 2007, 2018). In addition to the goodness of fit indices, we considered the theoretical underpinning of social capital and parsimony to develop interpretable factor structures during the model selection process (Gregorich, 2007; Myung, 2000).

3.3 Result

In the analytical sample (n = 12,473) – compared to women – men were older (Average age: men = 44 years, women = 30 years; p-value = 0.00). Men had significantly higher educational attainment and were more engaged in economic activities. Within the sample, 78.7%, (n = 9,816) respondents were married and 93% (n = 1,876) of the respondents who were never married (Single) were women. Table 3.2 presents the demographic characteristics of the respondents disaggregated by gender. Majority of the participants were Hindu and belonged to the schedule caste and schedule tribe.

Table 3.2: Demographic characteristics of study participants disaggregated by gender

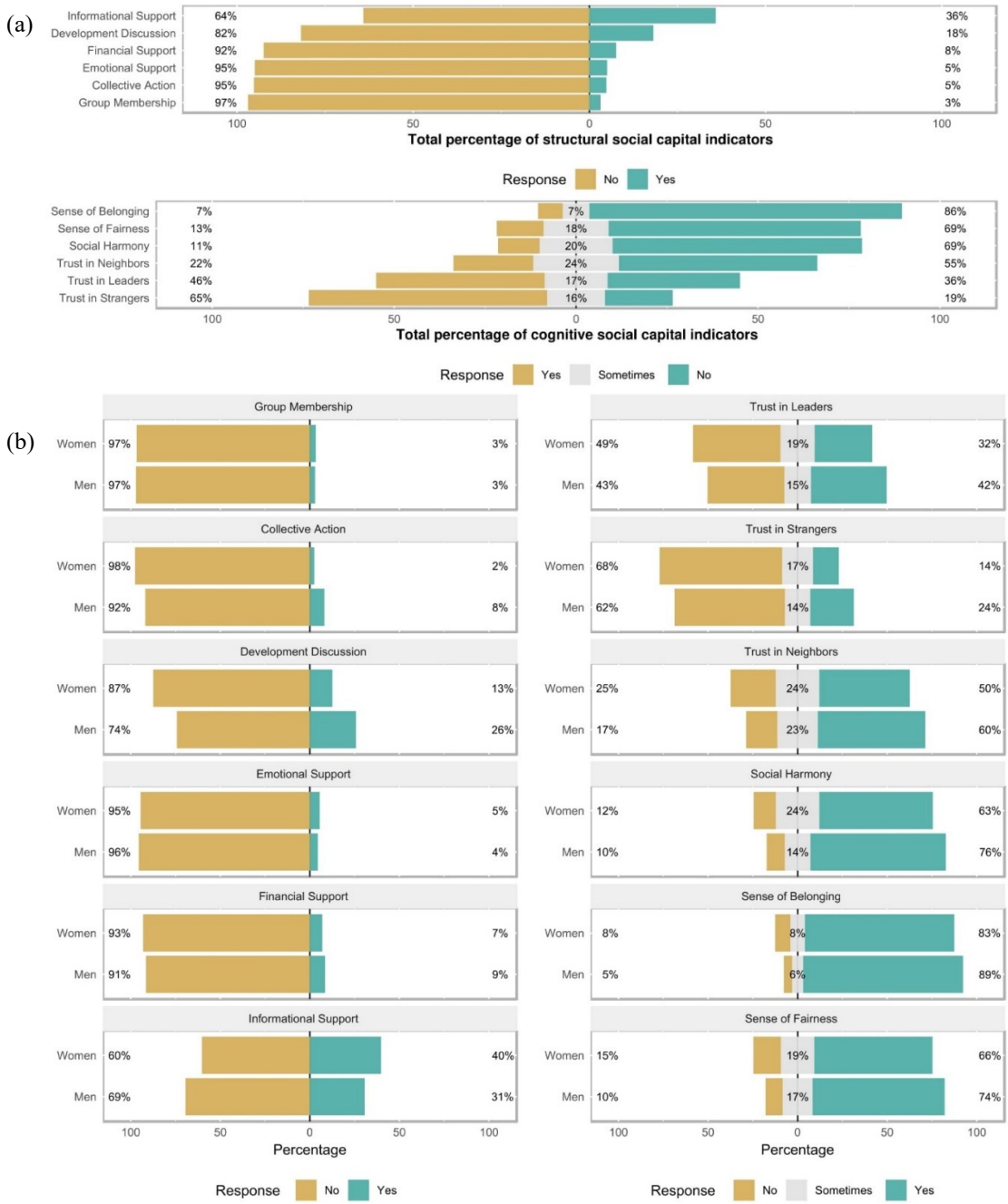
Participants Characteristics	**Men** (n=5,287)		**Women** (n= 7,186)		**P Values**	**Total** (n=12,473)
	n	**%**	**n**	**%**		**n**
Education						
Illiterate	1,747	36	3,168	64		4,915
Up to Primary	1,385	49	1,465	51	0.00	2,850
Above Primary	2,155	46	2,545	54		4,700
Occupation						
Cultivator	2,878	96	133	4		3,011
Wage laborer	1,541	90	171	10	0.00	1,712
Other Occupations	647	38	1,051	62		1,698
Unemployed/Student/Housewife	221	4	5,827	96		6,048
Marital Status						
Single	136	7	1,876	93		2,012
Married	4,857	49	4,959	51	0.00	9,816
Widowed/Divorced/Separated	294	46	350	54		644
Religion						
Hindu	4,747	43	6,318	57	0.00	11,065
Muslim and Others	540	38	868	62		1,408
Social Caste						
General	915	41	1,344	59		2,259
Schedule Caste and Schedule Tribe	2,509	44	3,185	56	0.00	5,694
Other Backward Caste and Others	1,863	41	2,657	59		4,520

Note: % column represents row percentage of categories of the sample

Figure 3.1 shows the percentage distribution of the 12 social capital indicators. Less than 10% of respondents reported any group membership, collective action or receiving any emotional or financial support within the last 12 months. While positive (yes) responses of the structural indicators were low; the six cognitive items had higher positive responses ranging from 18.58% (trust in strangers, n= 2,318) to 85.89% (sense of belonging, n= 10,713). All indicators presented a statistically significant difference

between men and women (p-value < 0.05), except for group membership. Men reported higher collective action and development discussion and acquiring financial support compared to women. For all cognitive social capital items, men had a significantly higher positive response (yes), and women reported 'sometimes' more frequently.

Figure 3.1: Distribution of social capital indicators for the total sample (a) and by gender (b)



Note: *All social capital indicators presented a statistically significant difference between men and women ($\chi 2$ P value < 0.05), except for Group Membership*

Results for factor and measurement invariance analysis are presented in the following sequence: (a) Development of a base model for social capital factor structure from the total sample disregarding gender, (b) Assessing level of measurement invariance of the base model across gender, and (c) Re-estimating the social capital factor structure separately for men and women.

3.3.1 Factor structure of the total sample disregarding gender

To explore the factor structure of the social capital of the total sample, we conducted three EFAs with two to four-factor solutions using the first random sample subset (n = 6,207). While, both three and four-factor EFA presented adequate model fit, four-factors solution had the best fit statistics (RMSEA = 0.02, CFI = 0.99, TLI = 0.98, χ^2 value = 57.83, df = 24, $p<0.01$). Based on the geomin rotated factor loading of the EFA model the four possible factors were- Factor 1: *Organizational Participation* (group membership, collective action, development discussion), Factor 2: *Social Support* (emotional support, financial support, informational support), Factor 3: *Trust* (trust in leaders, trust in neighbors, trust in strangers), and Factor 4: *Social Cohesion* (social harmony, sense of belonging, sense of fairness). We also investigated the polychoric correlation matrix of the 12 social capital items to interpret the result of the EFA and found that the correlations between the items loaded on the single factor were higher than the correlation between the items associated with two different factors (Data is not shown, see Appendix 3 for more details). Next, while assessing the generalizability of the four-factor solution CFA model also presented a good model fit: RMSEA= 0.03, CFI = 0.96, TLI = 0.95, SRMR = 0.04, χ^2 value= 274.45, df= 48, $p<0.01$. Table 3.3 shows the geomin rotated factor loading of the four-factor solution of EFA and CFA models.

Table 3.3: Factor loadings for exploratory and confirmatory factor analysis with four-factor solutions of 12 SASCAT-I indicators

Indicators	Unstandardized Loadings for EFA [a]				Standardized Loadings for CFA [b]			
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 1	Factor 2	Factor 3	Factor 4
GM	**0.24***	0.18*	0.01	0.03	0.29*			
CA	**1.08***	-0.01	-0.03*	0.02	0.84*			
DD	**0.52***	0.19*	0.09*	-0.06	0.74*			
ES	0.01	**0.52***	0.10*	-0.10*		0.48*		
FS	0.01	**0.44***	-0.03	0.08		0.42*		
IS	0.01	**0.48***	-0.01*	0.11*		0.56*		
TL	0.01	0.04	**0.73***	0.03			0.68*	
TS	0.11*	-0.04	**0.46***	0.01			0.52*	
TN	-0.04	-0.01	**0.52***	0.36*			0.74*	
SH	0.15*	-0.09*	0.11*	**0.63***				0.72*
SB	-0.07*	0.09*	0.00	**0.79***				0.70*
SF	0.13*	0.07	-0.04	**0.36***				0.36*

Note: EFA = Exploratory Factor Analysis, CFA = Confirmatory Factor Analysis
a = EFA of Random Subset 1 (n = 6,207), b = CFA of Random Subset 2 (n = 6,266)
GM = group membership, CA = collective action, DD = development discussion, ES = emotional support, FS = financial support, IS = informational support, TS = Trust in Leaders, TS = Trust in Strangers, TS = Trust in Neighbors, SH = social harmony, SB = sense of belonging, SF = sense of fairness
Factors: F1= Organizational participation, F2 = Social Support, F3 = Trust, F4= Social Cohesion
Goodness of fit Indices for EFA: RMSEA= 0.02, CFI = 0.99, TLI = 0.98, SRMR = 0.02, χ^2 value= 57.83, df= 24, p<0.01
Goodness of fit Indices for CFA: RMSEA= 0.03, CFI = 0.96, TLI = 0.95, SRMR = 0.04, χ^2 value= 274.45, df= 48, p<0.01
* = P <0.05

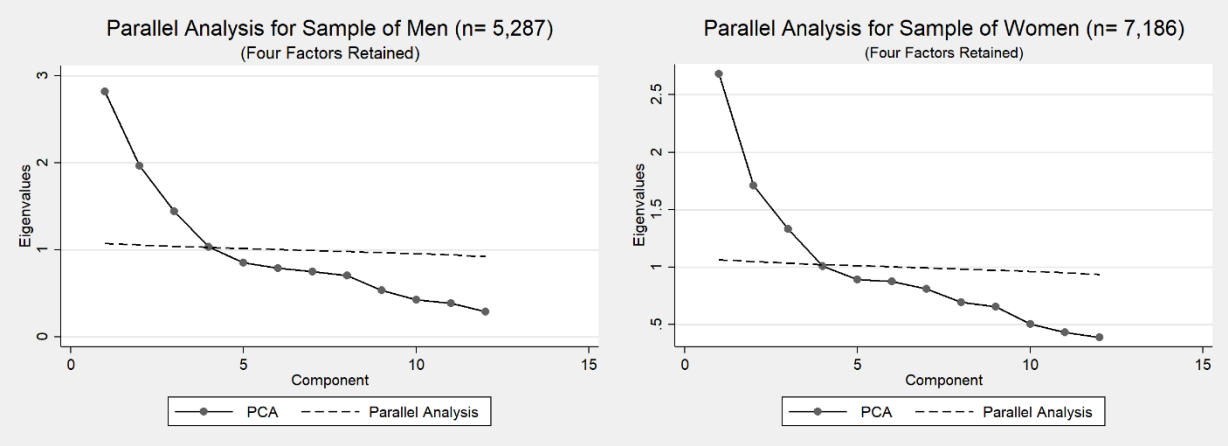
The two cognitive social capital factors of the CFA model, *Trust* and *Social Cohesion*, had a high correlation coefficient (0.72) which indicated a three-factor solution might provide a simpler factor structure. To assess this assumption, a three-factor CFA model was implemented considering *Organizational Participation*, *Social Support* and one overall *Cognitive factor* as the three latent factors and indicated an adequate fit (RMSEA= 0.03, CFI = 0.94, TLI = 0.92, SRMR = 0.05, χ^2 value= 426.62, df= 51, p<0.01). However, Satorra-Bentler scaled chi-square difference test indicated that the three-factor solution fitted the data rather poorly (Scaled χ^2 = 132.49, df= 3, p<0.05), which concluded a four-factor model was a better fit for the total sample when we ignored gender.

3.3.2 Multiple-group measurement invariance analysis across gender

In the sequence of assessing measurement invariance, Horn's (1965) parallel analysis was independently performed among the sample of men (n= 5,287) and women (n = 7,186) to assess the

dimensional invariance. The result suggested four common factors could be extracted from both samples (Figure 3.2).

Figure 3.2: Scree plots indicating the possible number of factors in a sample of men and women



Note: Figures illustrates the expected eigenvalues (the solid line) and parallel analysis (the dotted line), PCA = Principal Components Analysis

Next, a correlated four-factor solution was used to assess whether social capital factor structure was quantitatively equivalent across gender. Model fit and comparison statistics are presented in Table 3.4. The four-factor configural model (Model 1) with no equality constraints presented adequate fit to the data across gender (RMSEA= 0.03, CFI = 0.95, TLI = 0.93, SRMR = 0.04, $\Delta\chi^2 = 661.78$, $\Delta df = 96$, $p<0.05$). Next, considering the same factors loading of the corresponding items across gender, the configural model was compared with the metric model (Model 2). Satorra-Bentler scaled-corrected chi-square difference test indicated imposing the equality constraints on factor loading significantly reduced the model fit from the configural model ($\Delta\chi^2 = 93.00$, $\Delta df= 12$, $p<0.05$). This could indicate one or more factors might have differential levels of association with their items for men and women.

Table 3.4: Tests of measurement invariance of SASCAT-I across gender for four-factor solutions

Model to assess the level of invariance		Goodness-of-Fit Indices Four-Factor Solution[3]						Difference Test Indices[1]			
		χ^2	df	RMSEA	CFI	TLI	SRMR	vs.	$\Delta\chi^2$	Δdf	P value
Model 1	Configural	661.78	96	0.03	0.95	0.93	0.04	-	-	-	-
Model 2	Metric	747.97	108	0.03	0.95	0.93	0.05	1	93.00	12	0.00
Model 2x	Partial Metric[2]	659.34	102	0.03	0.95	0.94	0.05	2	10.31	6	0.11
Model 3	Scalar	907.58	118	0.03	0.93	0.92	0.05	2x	161.37	16	0.00

Note: χ^2 = chi square statistic; df = degree of freedom, RMSEA= root-mean-square error of approximation; CFI = comparative fit index; TLI= Tucker Lewis index; SRMR = standardized root-mean-square residual
1 = For WLSMV estimation $\Delta\chi^2$ is used to perform the Satorra-Bentler Scaled Chi-Square Difference Test
2 = Factor loading of six of the cognitive items (Trust in Leaders, Trust in Strangers, Trust in Neighbors, Social Harmony, Sense of Belonging and Sense of Fairness) were freed
3 = Four Factor Solution: F1= Organizational participation, F2 = Social Support, F3 = Trust, F4= Social Cohesion

As metric invariance was not supported, we examined the modification indices of Model 2 and observed factor loadings of all six cognitive social capital items were not equivalent across gender and they should be estimated freely. To statistically assess this phenomenon, a partial metric invariance model (Model 2x) was implemented by imposing equality constraints only on the six structural social capital factor loadings. We found the partial metric model fits the data significantly better than the full metric invariance model ($\Delta\chi^2 = 10.31$, $\Delta df = 6$, $p = 0.11$). Next, by holding both factors loading and intercepts to be equal across gender groups scalar invariance was tested (Model 3). However, it resulted a significantly worse model fit compared to the partial metric model ($\Delta\chi^2 = 161.37$, $\Delta df = 16$, $p = 0.00$). Thus, the measurement invariance analysis suggested the factor structure of social capital is not equivalent for men and women.

3.3.3 Re-estimation of factor structures of social capital for men and women

After the measurement invariance analysis, we were unable to achieve scalar invariance and concluded that the factor structure of social capital measured by the SASCAT-I was not quantitatively similar across gender. To reevaluate the social capital factor structure for each gender – in the final step – the four-factor EFA model was fitted separately among the men (n = 2,588) and women (n = 3,619) of random sample subset one. Both the four-factor EFA model for men and women indicated adequate model fit (Table 3.5). Consecutively, to assess the generalizability of the EFA models, CFA models with

the four-factor solution were fitted with the sample of random subset two (men = 2,699 and women = 3,567).

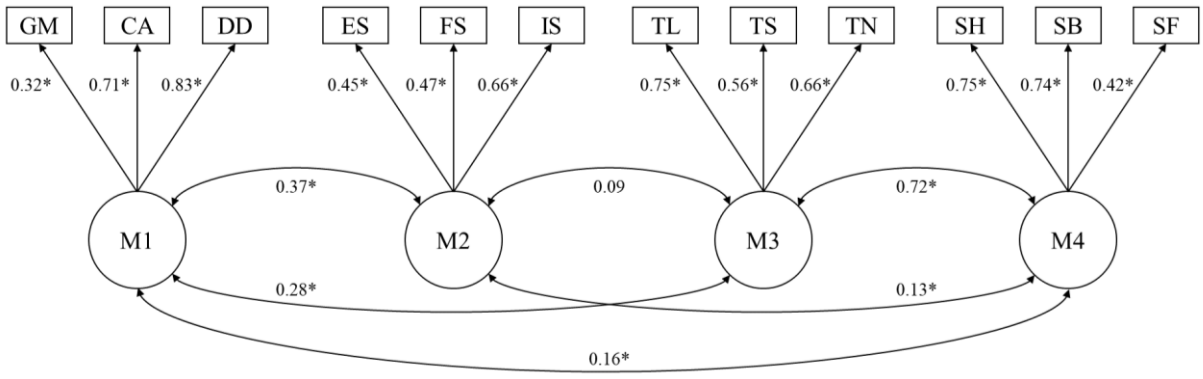
Table 3.5: Goodness-of-fit indices from single level EFA and CFA stratified by gender

Model		Goodness-of-Fit Indices					
		χ^2	df	RMSEA	CFI	TLI	SRMR
Exploratory Factor Analysis							
Men	4-Factor	49.80	24	0.02	0.99	0.97	0.04
	3-Factor	128.10	33	0.02	0.96	0.92	0.06
Women	4-Factor	35.37§	24	0.01	1.00	0.99	0.03
	3-Factor	71.17	33	0.02	0.99	0.98	0.04
Confirmatory Factor Analysis							
Men	4-Factor	261.24	48	0.04	0.93	0.90	0.06
	3-Factor	332.15	51	0.05	0.91	0.88	0.07
Women	4-Factor	121.97	48	0.02	0.98	0.97	0.05
	3-Factor	226.50	51	0.03	0.94	0.92	0.05

Note: § = $p > 0.05$, $\chi 2$ = chi square statistic; df = degree of freedom, RMSEA= root-mean-square error of approximation; CFI = comparative fit index; TLI= Tucker Lewis index; SRMR = standardized root-mean-square residual
EFA of Men in Random Subset 1: n = 2,588, EFA of Women in Random Subset 1: n = 3,619
CFA of Men in Random Subset 2: n = 2,699, CFA of Women in Random Subset 2: n = 3,567

The CFA model for men (n = 2,699) with the four-factor solution presented an adequate fit to the data (RMSEA= 0.04, CFI = 0.93, TLI = 0.90, SRMR = 0.06, χ^2 value= 261.24, df= 48, $p<0.01$). Figure 3.3 presents the path diagram showing the standardized factor loadings and inter-factor correlations of that model. The standardized factor loadings for individual man's social capital ranged from 0.32 (group membership) to 0.83 (development discussion), and all factor loadings were significantly different from zero ($p<0.05$). The inter-factor correlation between *Organizational Participation* and *Social Support* was 0.37 ($p<0.05$). On the contrary, cognitive social capital factors (*Trust* and *Social Cohesion*) were highly correlated (correlation coefficient = 0.72, $p<0.05$) which indicated a possible simpler three-factor model for men. However, the three-factor CFA model for men presented both overall poor fit to the data (RMSEA= 0.05, CFI = 0.91, TLI = 0.88, SRMR = 0.07, χ^2 value = 332.15, df = 51, $p<0.01$) and resulted a significantly worse model fit compared to four-factor model (Satorra-Bentler scaled $\Delta\chi^2 = 65.72$, $\Delta df = 3$, $p<0.05$).

Figure 3.3: Path diagrams presenting with standardized factor loadings and inter-factor correlations of four-factor CFA model for men (n = 2,699)

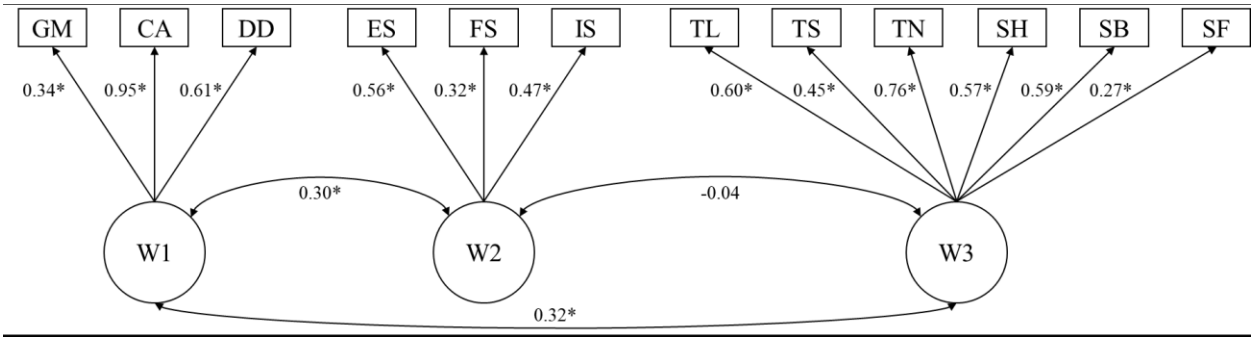


*Note: * = P <0.05*

Factors: M1= Organizational Participation, M2 = Social Support, M3 = Trust, M4= Social Cohesion
Goodness of fit Indices: RMSEA= 0.04, CFI = 0.93, TLI = 0.90, SRMR = 0.06, $\chi 2$ value= 261.24, df= 48, p<0.01
GM = Group Membership, CA = Collective Action, DD = Development Discussion,
ES = Emotional Support, FS = Financial Support, IS = Informational Support, TS = Trust in Leaders, TS = Trust in Strangers,
TS = Trust in Neighbors, SH = Social Harmony, SB = Sense of Belonging, SF = Sense of Fairness

Among the random sample subset two of women (n = 3,567), the four-factor CFA model also indicated satisfactory goodness of fit and a high correlation between *Trust* and *Social Cohesion* (correlation coefficient = 0.71, p<0.05). However, unlike men, the three-factor women had an overall satisfactory goodness of fit indices (RMSEA= 0.03, CFI = 0.94, TLI = 0.92, SRMR = 0.05, χ^2 value= 226.50, df= 51, p<0.01). Figure 3.4 presents the path diagram with the standardized factor loadings and inter-factor correlations for the three-factor model for women.

Figure 3.4: Path diagrams presenting with standardized factor loadings and inter-factor correlations of three-factor CFA model for women (n = 3,567)



Note: ** = P <0.05*

Factors: W1= Organizational participation, W2 = Social Support, W3 = Cognitive Social Capital
Goodness of fit Indices: RMSEA= 0.03, CFI = 0.94, TLI = 0.92, SRMR = 0.05, $\chi 2$ value= 226.50, df= 51, p<0.01
GM = Group Membership, CA = Collective Action, DD = Development Discussion, ES = Emotional Support, FS = Financial Support,
IS = Informational Support, TS = Trust in Leaders, TS = Trust in Strangers, TS = Trust in Neighbors, SH = Social Harmony,
SB = Sense of Belonging, SF = Sense of Fairness

The most parsimonious social capital structure for an individual woman included three factors: *Organizational Participation, Social Support,* and an overall *Cognitive factor*. The standardized factor loadings ranged from 0.27 (sense of fairness) to 0.95 (collective action), and all factor loadings were significantly different from zero ($p<0.05$). The inter-factor correlation between the three factors are low (*Organizational participation* and *Social Support* = 0.30, *Social Support* and *Cognitive factor* = 0.32, *Organizational participation* and *Cognitive factor* = -0.04).

3.4 Discussion

3.4.1 Discussion of the result

Using a sample population from rural UP, our study explored factor structure and measurement invariance of social capital across gender by a short and simple quantitative tool, SASCAT-I. Using the measurement invariance analysis, the study concluded the structure of the social capital for men and women was not the same.

To conclude that the identified social capital factors for men and women were equivalent, it was necessary to achieve scalar invariance. However, only a partial metric invariance was established suggesting the factor loadings of *Organizational Participation* and *Social Support* were statistically similar, while the factor loadings of the *Trust* and *Social Cohesion* were different across gender. The result from the gender-stratified analysis demonstrated the social capital of men had four unique factors (*Organizational Participation, Social Support, Trust* and *Social Cohesion*). We found a similar four-factor solution was also appropriate for women. However, a simplified three-factor solution (*Organizational Participation, Social Support,* and an overall *Cognitive factor*) was identified as the best-fitted and most parsimonious model for individual woman's social capital. The original SASCAT developed by De Silva et al. (2006) presented three constructs (Group membership/Social support, Citizenship and an overall Cognitive social capital). Furthermore, cognitive validation of SASCAT-B in Bangladesh considered three structural (Group membership, Social support and Collective action) and two cognitive constructs (Trust and Social cohesion) (Story et al., 2015a).

In the literature, the theoretical interpretation of social capital through the gender lens indicated social network are not genderless (Addis & Joxhe, 2017; Leeves & Herbert, 2014). Social interaction of an individual with others and others' behavior toward him or her builds one's social network. And because of the inherent difference in the culture and social norm regarding gender, the structure and components of social relationships and network evolve. Previous studies exploring social capital seldom

included a gender dimension. This study included a gender-specific data collection and analytical approach to identify the difference in social capital structure and filled the gap between empirical investigation and theoretical interpretation of the multidimensional and gendered concept of social capital.

The invariance of *Organizational Participation* and *Social Support* across gender can be explained with two arguments. First, in the descriptive analysis, we have found very few respondents reported to be a part of any community group and received financial or informational support from the community. While living in a rural and economically deprived community – irrespective of gender – the respondents may have a limited number of social structures for engagement with the community which is essential for generating structural social capital. And the second explanation is related to how structural social capital questions were framed. In the original SASCAT and in our modified tool, the six indicators related to structural social capital were based on Bourdieu's (1986) network-based resource concept of social capital. While exploring the effect of material deprivation and poverty, Lynch et al. (2000) explained that the emergence of the structural social capital is much more dependent on socioeconomic inequalities rather than psychosocial factors. Perhaps in the context of rural UP, the dimensions of structural social capital are driven by socioeconomic factors rather than gender.

On the other hand, our result showed the factor loadings of the *Trust* and *Social Cohesion* were different across gender. This could indicate a gender difference in the way men and women perceived *Trust* and *Social Cohesion*. Here, Keren Cook's (2005) work on trust and social exchange theory can help us to unpack how the perception of the cognitive component of social capital may vary across gender. Our result indicated men in the rural UP were much more engaged in economic activity, and they also reported engaging in financial exchange more frequently via receiving social support. According to Cook, the financial exchange comes with some uncertainty and obligation. And here *Trust* or trustworthiness matters to evaluate the element of risk that comes with the financial exchange.

According to social role theory, social interactions, trust, and cohesiveness among men depend on their strategic or agentic behavior which often focuses on task completion or exchange of resources (Bakan, 1966; Buchan, Croson, & Solnick, 2008; Feingold, 1994). Other types of social exchange (such as emotional support or informational support) – in contrast to economic exchange – depends on personal social relations which are often influenced by the "*act of exchange, not the mode of exchange*" (Cook & Emerson, 1978). In our sample, a significantly higher number of women reported receiving emotional support and informational support. Unlike financial supports, these types of social exchange require cooperative behavior and a higher perception of cohesiveness and harmony (Cross & Markus, 1993). While we are framing our explanation of how men and women may perceive *Trust* and *Social Cohesion,* one critique of our explanations can be – the social exchange theory and social role theory were developed in the context of western culture. However, our arguments still hold in the highly gender inegalitarian patriarchal society of UP (Rajadhyaksha & Velgach, 2015). Though women are getting empowered in India due to education, modernization and industrialization, gender inequality still prevails in rural UP (Srivastava, 2010).

Other than the unique factor configuration across gender, one noteworthy finding emerged from the result. The correlation between *Organizational Participation* and *Social Support* is more intuitive and can be explained theoretically. Bourdieu's (1986) and Lin's (1999) theorization of social capital as embedded resources of one's social network aligns with this result. However − irrespective of gender – *Social support* had an almost negligible association with the individual's *Trust* or *Social Cohesion* (in case of women participant *cognitive factor*). This contradicts the traditionally perceived role of trust and cohesiveness assisting people towards sharing informational or material resources (Anderson & Mellor, 2008). The rural and poor socioeconomic context of the study area may provide a possible explanation of this finding. *Social support*, which often is the expression of how social capital is being utilized, is generally used as an "*informal insurance*" or risk sharing strategy. However, with high economic stress,

social norm such as trust and solidarity may not be enough to permit households and community to share resources with other (Kanbur, Lustig, & World Bank, 2000).

Disregarding gender, respondents of our study reported low organizational activities and sharing of resources. In contrast, participants were reporting somewhat positively regarding their trust and relationship with others in the community. This provides an opportunity to leverage the cognitive social capital to support the development of social infrastructure and institutions (Justino, 2006). However, it is necessary to acknowledge – what *Trust* and *Social Cohesion* mean to a man can be different from a woman in rural UP. Thus, implementation of any intervention to build social capital in rural UP should consider the role of gender (Chaudhuri, Paichayontvijit, & Shen, 2013; Leeves & Herbert, 2014; Westermann et al., 2005).

3.4.2 Strengths, limitations and future direction

While multiple cognitive and psychometric validation studies on SASCAT were already being conducted – to the best of our knowledge – our study is the first to examine measurement invariance of social capital's factor structure using psychometric analysis across gender. A large population-based sample of over twelve thousand rural adults was the major strength of this study. Performing cognitive validation techniques to contextually adapt the scale strengthened our study further. Psychometric techniques such as factor analysis is a model-based approach. As renowned statistician George Box mentioned, "*The most that can be expected from any model is that it can supply a useful approximation to reality: All models are wrong; some models are useful*" (Box, Hunter, & Hunter, 2005). Multiple models with different factor structure can have a set of similar goodness of fit statistics. Hence, the statistical analysis of this study was driven by a robust theoretical framework developed by social capital researchers.

Using a multiple-group CFA approach we provided further insights into the factor structure of social capital for this population. Contributing to the tradition of establishing measurement invariance of

any psychosocial constructs, our study addresses the possible measurement bias across gender and advance the literature of social capital (Agampodi et al., 2015; Kawachi et al., 2013; Stone, 2001; Villalonga-Olives & Kawachi, 2017). On a practical level, the SASCAT-I can measure social capital through a short module within any broader study in a rural population of India. However, calculating a total scale score using this tool by summing the items score or taking a mean will produce a biased result. It is necessary to acknowledge the multidimensionality, and the difference in social capital structure across gender and a factor analytical model should be considered for analyzing the data collected by the SASCAT-I.

The result of this study should be interpreted along with its limitations. The sample of our study may be representative for economically disadvantaged rural adults of UP, India – the findings of our study may not be extended into other settings or among any subset of our sample. We approached the measurement invariance having a gender-binary perspective. However, we decided this was the best approach to define gender in the context of Rural UP. During the analysis, we include the entire sample of the respondent and did not restrict the sample based on any specific criteria (such as age, occupation, marital status, etc.), because we only wanted to explore the gender dimension among the entire sample. During data collection, the interviewers were not gender-matched with the respondents that might affect the way that men and women responded differently to these questions of SASCAT-I. We recommend further cognitive testing of how data collection process affects the performance of SASCAT-I.

We also recommend future psychometric exploration of social capital among other social stratifiers. This study only demonstrates measurement invariance of social capital measured by SASCAT-I across gender. The survey data collection procedure selected men and women of the households as independent samples. Thus, the assessment of measurement invariance between men and women was most logical. Nevertheless, future studies can provide further understandings into the structure of social capital by exploring measurement invariance analysis across socio-cultural and economic characteristics such as religion, caste, and the socioeconomic class.

Within the scope of the study, we did not explore the reliability of the SASCAT-I. Recent Monte Carlo simulation studies recommended advanced statistical methods to assess reliability for CFA (Geldhof, Preacher, & Zyphur, 2014). Applicability of this procedure is limited as they only assess the reliability of unidimensional construct using continuous data, whereas SASCAT-I is multidimensional and contain categorical items.

3.5 Conclusion

Everyday social capital affects the health and wellbeing of individual and community, and acknowledging gender difference in social capital can help us to promote equality for women. The body of social capital literature using self-reported measure has a limited example of measurement invariance. Addressing this gap, this paper embarked on a journey to assess the factor structure and measurement invariance across gender for SASCAT-I. Our finding suggests – while the structural components of the social capital (*Organizational participation* and *Social Support*) have a similar relationship with the corresponding items – the difference in the cognitive component makes social capital of men and women unique. By applying the factor analytical framework, this study provides sufficient evidence regarding the psychometric properties of the SASCAT-I for the rural population of UP, India. And, more research is needed to explore measurement invariance of social capital across other socio-demographic factors.

4. Social capital and utilization of immunization services: a multilevel analysis in rural Uttar Pradesh, India

Abstract

Utilization of preventive care, such as immunization, has been shown to be associated with social capital. Despite the extensive effort to integrate the immunization program within the community, only 66.5% of children in India are receiving all three doses of diphtheria–pertussis–tetanus (DPT3) immunization. This study explored the influence of individual and community-level social capital on receiving DPT3 immunization among 12-59 month children in rural Uttar Pradesh (UP), India.

Data from a multistaged cross-sectional survey of 6,218 households from two districts of UP was used to collect the immunization status of 12-59 month children. The analytical sample of this study included 2,239 children from 1,749 households nested within 346 communities. We used multilevel confirmatory factor analysis to generate standardized factor scores of social capital constructs (*Organizational Participation, Social support, Trust* and *Social cohesion*) of the household heads and mothers both at individual and community level. These eight measures of social capital were used in the multilevel logistic regressions to explore the independent and contextual effect of social capital on a child's DPT3 immunization status.

The result revealed only social capital of the mother was associated with a child's immunization status. Specifically, community level *Organizational Participation* and *Social Cohesion* of the mothers increased the odds of DPT3 vaccination, whereas an individual mother's *Organizational Participation* decreased the odds. However, the mother's individual *Organizational Participation* was positively associated with DPT3 immunization only for those mothers who lived in a wealthy community or in a community where Village Health Sanitation and Nutrition Committee was proactive. Despite controlling for a large number of covariates significant household and community level variation of DPT3 immunization remained. Thus, further research is needed – possibly with longitudinal data and in-depth qualitative exploration – to explore additional predictors and the causal effects of social capital on immunization in UP, India.

4.1 Introduction

Childhood immunization is considered one of the "Best Buys" and it is not only cost beneficial for the health system, the net return of immunization is predicted to be 44 times the cost of the program (Ozawa et al., 2016; Ozawa, Mirelman, Stack, Walker, & Levine, 2012). It also exerts far-reaching impacts by improving the cognitive development of children, educational attainment and reducing curative treatment cost (GAVI, 2017). While the benefit of having a reliable immunization program is unequivocal, India is missing this opportunity. India initiated the Expanded Programme of Immunization (EPI) in 1978 followed by the Universal Immunization Programme (UIP) in 1985 (Lahariya, 2014). After three decades, only 62% of the children aged 12-23 months are under full immunization coverage (ranging from 91% in Puducherry to 35% in Nagaland). Though Uttar Pradesh (UP), most populous states of India, has seen a 28% increase in coverage since 2005, it still ranks as one of the low performing states of India with only half the children (51%) being fully immunized (International Institute for Population Sciences & ICF, 2017).

The decision of immunizing children may not be only a matter of personal preference of the parents or inefficiency of the health system. In a systematic review exploring missed opportunities for immunization, Sridhar et al. (2014) identified parenteral awareness, mode of communication and interaction within community, cultural norms and trust as critical factors which can affect utilization of immunization service. Cumulatively all these contextual factors can be linked with social capital. Considering the utility of social capital, Bourdieu (1986) defined it as the aggregate of resources embedded within the social network and relationships of individuals and groups. In the time of need, these resources act as private goods and can be transformed into information, financial assistance or access to services, etc. On the other hand, Putnam (1995) conceptualized social capital as the features of social organization such as network, norms, solidarity, and trust. According to him, it is a common good which allows the community to coordinate actions for mutual benefits.

To explain the multidimensional nature of social capital, Bain & Hicks (1998) categorized social capital by its structural and cognitive component. Structural social capital indicates the associational network between individual and community (Bourdieu, 1986b). Objective measures of civic engagement, community participation, and social support indicate structural social capital. On the other hand, cognitive social capital is defined by the perception of trust, social cohesion or solidarity among individuals and groups.

Based on the type of social association, social capital can be further reorganized into- 1) "vertical" or "linking" social capital which indicates associational relationship between individual or groups with unequal distribution of resources and powers and 2) "horizontal" social capital which reflects the social ties between individual or groups who are socially near-equals (Islam et al., 2006; Szreter & Woolcock, 2004). Putnam (2000) further subdivided "horizontal" social capital into "bridging" (social ties among near-equals from different social backgrounds) and "bonding" (social ties among family, friends, and neighbors). Despite the versatility of definition and classification, social capital can affect the health and behavior of individual and community (Lindström, 2008). This study aims to explore the role of individual and community level social capital on the utilization of immunization service in rural UP, India.

4.1.1 Immunization program in UP, India

UP achieved significant progress in reducing maternal and child mortality and morbidity during the era of Millennium Development Goals. However, the utilization of healthcare service is still low. Less than half (45.5%) of the currently married women aged 15-45 year use any contraceptive method, 26.4% have ≥4 ANC visits during pregnancy, and only 67.8% have institutional delivery. Half (51%) of the children between the age of 12-23 months receive full immunization, and two-thirds (66.5%) receive all three doses of diphtheria–pertussis–tetanus vaccines (DPT3). UP also has a comparatively higher infant and neonatal mortality, almost 1.5 times greater than the national average (International Institute for Population Sciences & ICF, 2017).

To improve the service utilization and quality of care, in 2005 Ministry of Health and Family Welfare (MoHFW) of India initiated a systemwide reform of primary care through National Rural Health Mission which was later restructured as National Health Mission (NHM) (Ministry of Health and Family Welfare, 2005). NHM introduced *Janani Suraksha Yojana* (a national conditional cash transfer program to improve facility delivery), *Rashtriya Swasthya Bima Yojana* (a publicly financed insurance for hospital care), a new cadre of community health worker called *Accredited Social Health Activist* (ASHA), *Village Health , Sanitation and Nutrition committee* (VHSNC) and most importantly *Mission Indradhanush* – an intensified immunization campaign targeting to achieve 90% coverage of full immunization by 2020 in UP, Bihar, Madhya Pradesh and Rajasthan.

Since the inception of NHM and now under the *Mission Indradhanush* – community-based immunization campaign in UP is led by ASHA, Anganwadi Workers (AWW, a village nutrition and child development worker tenured by Ministry of Women and Child Development) and Auxiliary Nurse Midwife (ANM- a MoHFW's health worker assigned in the village sub-centers). Every month the triad of these healthcare providers organized *Village Health Nutrition Day* (VHND) to provide routine immunization to the children in the community. Organization and functioning of VHND are supported by VHSNC which is comprised of ASHAs, AWWs, ANMs, leaders of local government called Gram Panchayats (GPs) and other community-based organizations (Ministry of Health and Family Welfare, 2005). VHSNC is responsible for assisting ASHA and ANM by ensuring community participation, creating awareness on immunization and tracking children who are dropped out from the immunization schedule (Government of India, 2013).

Though the immunization program is highly embedded within the community to remove the access barrier, several health systems and community factors influence the degree of service utilization. From the health systems perspective – lack of human resources, absenteeism of providers, inadequate infrastructure and supplies, poor record-keeping and weak governance are the critical supply-side barriers resulting in the lower utilization (Bajpai et al., 2010; Sridhar et al., 2014; Vashishtha & Kumar, 2013).

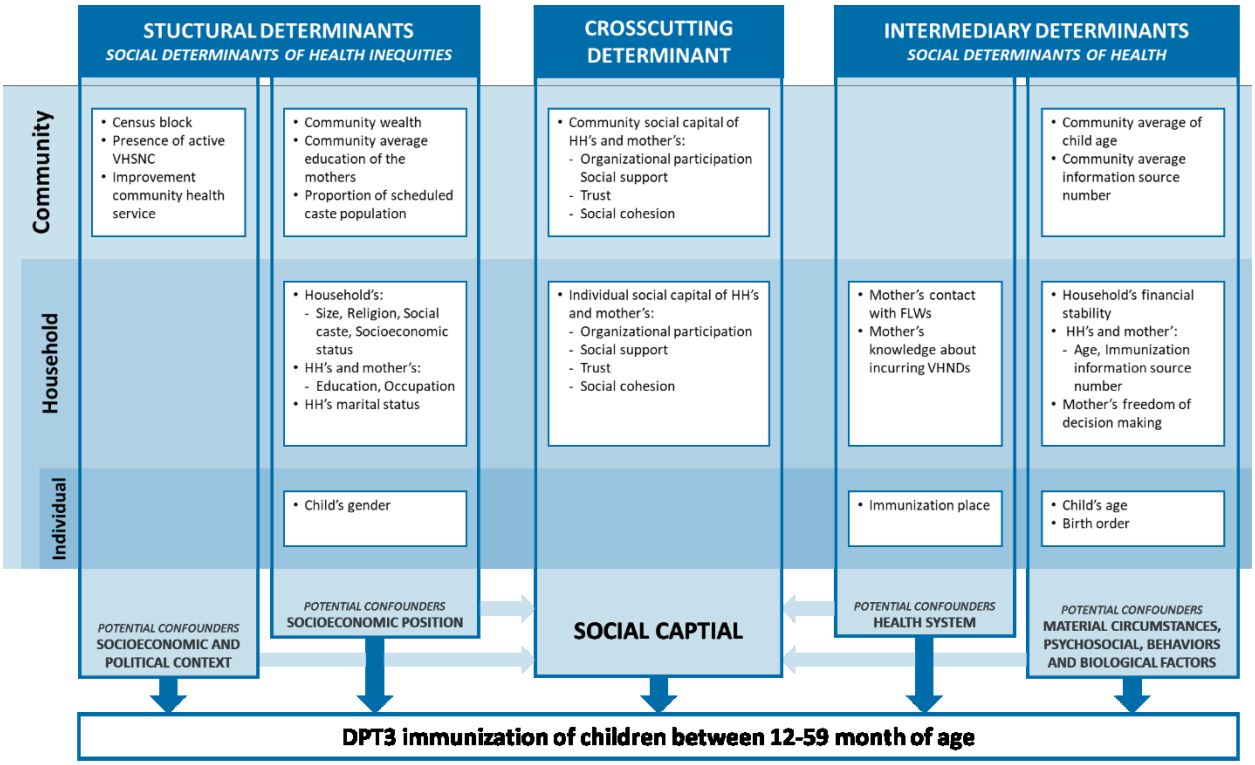
From the demand side – age and gender of the child, institutional delivery, mother's educational attainment, place of residence, caste, religion and socioeconomic status of the households were reported as significant predictors of immunization (Devasenapathy et al., 2016; Gupta et al., 2015; Shrivastwa, Gillespie, Kolenic, Lepkowski, & Boulton, 2015). However, contextual factors of the household and community have been shown to be associated with the immunization of children in India. These include knowledge, trust and social norms about immunization, functioning of community organization and community mobilization (Sahu, Pradhan, Jayachandran, & Khan, 2010; Scott, George, Harvey, Mondal, Patel, Ved, et al., 2017; Stephenson & Tsui, 2002; Story, 2014). India's experience with polio eradication perfectly depicts the importance of trust and social network while scaling up the immunization campaign (Deutsch, Singh, Singh, Curtis, & Siddique, 2017). To fight the deep-rooted resistance to immunization within the sociocultural norm in the hard-to-reach area, the government of India launched the Social Mobilization Network (SMNet). Employing more than 6000 Community Mobilization Coordinators, SMNet focused on building trust to change the social norm against immunization leading to a successful immunization campaign against polio.

Power dynamics, caste and socioeconomic composition of the village have been shown to exclude religious minorities and lower caste population from actively participating in the VHSNC and VHND activities (Kumar et al., 2016). Scott et al. (2017) also reported social hierarchies, cohesiveness, and norms in northern rural India influences the capacity and functionality of VHSNC and affecting essential services like immunization, maternal and child care and nutritional programs. In a unique caste-based social structure of rural UP where social norms, trust, and community support determine health-seeking behavior, considering social capital as a determinant for immunization is imperative. This presents an opportunity to understand how social capital is related to a critical health system performance indicator, utilization of DPT3 vaccine, in conjunction with other social determinants of health. Therefore, this study aimed to investigate the association of individual and community social capital on DPT3 immunization of 12-59 month children using a multilevel analytical framework.

4.1.3 Conceptualizing social capital as a social determinant of immunization

Exploring the relationship between social capital and health-seeking behavior is particularly challenging because of the ambiguity of definition and its multidimensional nature (Inaba, 2013). Shiell et al. (2018), in their review of 28 systemic reviews on social capital, argued that social context is not generally accounted while conceptualizing social capital as a determinant of health. We found a similar gap in the recent literature investigating the role of social capital on utilization of maternal and child healthcare in Peru, Ethiopia, Vietnam and India (Harpham et al., 2006; Silva & Harpham, 2007; Story, 2014) where the researchers accounted for a limited number of other social determinants in their analysis. Addressing this gap, the conceptual framework of our study was adapted from the WHO's Commission on Social Determinants of Health (CSDH) framework (World Health Organization, 2010) (Figure 4.1).

Figure 4.1: Conceptual framework to explore the role of social capital as a determinant of DPT3 immunization among 12-59-month-old children in UP, India



Note: Conceptual framework developed from WHO's Commission on Social Determinants of Health (CSDH) framework: https://www.who.int/sdhconference/resources/ConceptualframeworkforactiononSDH_eng.pdf

Similar to the CSDH framework, our conceptual framework stratified social determinants into three broad categories using the social-ecological perspective (McLeroy, Bibeau, Steckler, & Glanz, 1988). The first category is structural determinants which include socioeconomic position and socio-political context. Gender, socioeconomic status, race/ethnicity, education, etc. are included in this category, and they are the drivers of socioeconomic position. They create social stratification and hierarchy at the individual, household or community levels. The socio-political context includes governance, social policy, and cultural values which affects everyone in the community. All of these determinants in term develop the social context which grants differential levels of power and social position to individuals and groups (Graham, 2004). Structural determinants influence health or health-related behavior through a set of factors called intermediary social determinants of health. They are also broadly divided into two groups. The first group includes- psychosocial, behavioral and biological factors of individual or group, material circumstances for the living, etc. The CSDH model assumes socially disadvantaged groups living with unfavorable material circumstances often engage in health-damaging behavior leading to poor health outcomes. CSDH considered the health system as the second group of the intermediary determinants. Availability, accessibility, quality, and performance of the health services can lead to health disparities. If we consider India's community-based vaccination program, a robust health system can reduce inequality and financial burden among poor and also generate social capital through building social support networks, solidarity and social cohesion (Diderichsen, Evans, & Whitehead, 2001).

In between structural and intermediary social determinant of health, social capital is situated as a standalone and cross-cutting determinant of health. While structural and intermediary determinants influence both social capital and health, the constructs of social capital (e.g., trust, cohesiveness, social support, social participation) can independently influence health and care-seeking behavior of individuals and communities (Lindström, 2008). Based on the conceptual framework this study theorizes a higher

level of social capital may lead to a higher likelihood of child immunization after accounting for additional structural and intermediary determinants of health.

4.2 Method

4.2.1 Data source

The analysis of this study was based on a multistaged cross-sectional household survey conducted in two rural districts of UP from June to August 2017. The multi-topic survey was a part of baseline evaluation of a rural development initiative called Project Samuday lead by HCL Foundation (2018). The survey was implemented in 346 GPs of six rural census blocks of Hardoi and Sitapur districts. GPs are the lowest tier of the administrative unit in rural India and generally consist of one to four villages (Ministry of Panchayati Raj & Government of India, 2017). Since the inception of NHM in 2005, Government of India assigned one ASHA for each 1,000 population of the GPs (Government of India, 2018). Within each GP, the service area of a randomly selected ASHA was considered as the primary sampling unit (PSU), and from there 17-18 households were selected for interview using simple random sampling. Trained data collectors interviewed 6,218 household heads (≥18years) and all women between 15-49 year of age (n = 6,826) after receiving verbal informed consent.

The maternal and child care utilization module was responded by 2,001 ever-married women who have given birth in the last five years preceding the survey where they reported the immunization status of 2,724 under 59-month children. To avoid partially immunized child, we considered children between the age of 12-59 month as the unit of analysis. This yielded the final analytical sample of 2,239 children from 1,749 households in 346 GPs. Ethical approval of the study was received from the Institutional Review Board Office of Johns Hopkins Bloomberg School of Public Health, Maryland, USA and locally from Center for Media Studies, New Delhi, India.

4.2.2 Measurement and variables

Dependent variable

To investigate the relationship between social capital and immunization status, this study considered receipt of all three doses of DPT vaccines as the dependent variable. DPT3 immunization coverage is an internationally accepted indicator which is not only used to monitor health system performance (Becker, Pickett, & Levine, 2006; World Health Organization, 2018), but also provides critical insights into immunization service utilization at the individual and community level (Ababu et al., 2017; Acharya, Kismul, Mapatano, & Hatløy, 2018; Fatiregun & Etukiren, 2014). Similar to the Demographic and Health Survey (DHS) - immunization information was extracted using both immunization record and self-reported questions in our survey (International Institute for Population Sciences & ICF, 2017). We used both sources of information to generate DPT3 immunization status which was defined as a binary variable. The value "1" was assigned to those children who received all three DPT vaccines before 12 months according to an immunization card or the mother's report and "0" otherwise.

Explanatory variables

Based on the conceptual framework of the study (Figure 4.1), independent variables of the analysis were operationalized into crosscutting, structural and intermediary determinants at the individual, household and community level (See Appendix 5 for detailed descriptions).

Social capital: the cross-cutting determinant

Among the independent variables, social capital was the primary variable of interest at the household and community level. The social capital of the household head and mother of 12-59 month child was measured by SASCAT-I. This tool was developed and validated to measure structural and cognitive social capital constructs for multi-topic household surveys (De Silva et al., 2006; Story, Taleb, Ahasan, & Ali, 2015b). This study used of rapid cognitive interviewing technique to further adapt the tool

within the context of rural UP (Haeger et al., 2012). During the survey, each participant responded to 13 questions which assessed their participation in community groups, collective action within the community, received social support, the perception of trust and cohesiveness (See Appendix 6 for details). The questions from SASCAT-I was converted into 12 indicators, and we used multilevel factor analytical models to create composite measures of social capital (Table 4.1).

Table 4.1: Social Capital indicators generated from SASCAT-I in India

Social Capital Indicators	
Structural Social Capital Indicators: Binary Responses (Yes = 1, No = 0)	
Group membership [a]	In the last 12 months, participated in or received any benefit from any community group
Collective action	In the last 12 months, worked together with other community members and attempted to address a problem or common issue of the village
Development discussion	In the past 12 months, spoke with anyone about the development of the village
Emotional support	In the last 12 months, received any emotional social support
Financial support	In the last 12 months, received any financial social support
Informational support	In the last 12 months, received any informational social support
Cognitive Social Capital Indicators: 3 Point Likert Responses (Yes = 2, Sometime = 1, No = 0)	
Trust in leaders	Overall, trust in village leaders
Trust in strangers	Overall, trust in unfamiliar people residing in the village
Trust in neighbors	Overall, trust in village neighbors
Social harmony	People in this village generally have good relationships with each other
Sense of belonging	Feel that you belong to this village
Sense of fairness [b]	People in this village would try to take advantage of you if they get the chance

Note: a = Group Membership indicator is generated by merging Group participation and received benefit
b = Sense of Fairness is reversely coded (Yes = 0, Sometime = 1, No = 2)

First, independent exploratory factor analysis (EFA) was conducted for the sample of household heads and mothers. From both samples, four unique latent constructs of social capital were emerged – *Organizational participation*, *Social Support*, *Trust* and *Social Cohesion*. *Organizational Participation* was associated with: 1) membership in any community groups, 2) received benefit from any community groups, 3) collective action with the community and 4) engagement in any development discussion with any individuals about his/her community. Three indicators associated with received emotional, financial and information support were associated with the *Social Support* factor. Level of trust in leaders, neighbors and any unfamiliar person (strangers) in the community were associated with *Trust*. And *Social Cohesion* was related to three indicators: 1) "Do you think the majority of people in this village generally have good relationships with each other?" 2) "Do you feel that you have a sense of belonging to this

village?" and 3) "Do you think that the majority of people in your village would try to take advantage of you if they got the chance?". Considering the four-factor structure of social capital, multilevel confirmatory factor analytical (MCFA) models were implemented considering GPs as the level-two unit. Four standardized factor scores, as theoretically unique composite indicators of social capital, were generated both at individual and community level. While the factor analysis was conducted with the entire sample, standardized factor scores of household heads (n = 1,749) and mothers of 12-59 month child (n = 1,779) were included in this analysis.

Covariates related to structural determinants

While exploring the relationship between immunization and social capital, previous literature usually adjusted for covariates which can be considered as structural determinants (Nagaoka, Fujiwara, & Ito, 2012; Rönnerstrand, 2014; Story, 2014; Vikram, Vanneman, & Desai, 2012). Considering the context of these previous studies, we have stratified structural determinants of immunization at the individual, household and community levels (Figure 4.1). Child's gender was considered as the only individual-level structural determinant. As level two (household) covariates we included education and occupation of household heads and mothers, marital status of the household heads; household's size, religion, social caste, and socioeconomic status. As the socioeconomic status, each household was assigned into a wealth quintile of a linear index created by principal components analysis (PCA) of household assets of the entire sample of the survey (n= 6,218) (Deon Filmer & Pritchett, 2001). Community-level structural determinants were divided into two categories. The first group was the socioeconomic position of the community – including the average asset index of all household from a PSU, community average educational attainment of the mothers and proportion of scheduled caste population in the GP. The second group reflected sociopolitical context of the community – including administrative boundaries (census blocks), the presence of active VHSNC, and improvement of the health service of the community measured by averaging all household heads response to the question "How has the functioning of government health services in your village changed since last year?"

Covariates related to intermediary determinants

Intermediary determinants for immunization were divided into two broader categories. The first set included material circumstances for living, psychosocial, behavioral and biological covariates. As biological factors self-reported age of the household heads, mothers and children, and the birth order of the children were included. Child's age was categorized into four age cohort – 12-23, 24-35, 36-47 and 48-59 months. Also, as a contextual covariate average age of the child was included at the community level. At the household level, material circumstances for the living were measured by the household head's perceived financial stability (Sridhar et al., 2014). Mothers' perceived ability of decision making was considered as a psychosocial attribute for the immunization status of the child (Babalola, 2009; Glatman-Freedman & Nichols, 2012). It was measured by asking "How much freedom do you have in making personal decisions?". To account for the lifestyle, knowledge, and health-related behavior, we included knowledge of immunization of household heads and mothers (measured by the reported number of sources for immunization information). The total number of information sources for immunization of both household heads and mothers was averaged at the PSU level and considered as a contextual variable.

The second set of intermediary determinants for immunization were related to the health system and its interface with individual and household. We included the facility where most of the immunization was received as an individual child level explanatory variable. Mother's regular contact with the community health workers (ASHA, AWW or ANM) within the last six months and her knowledge regarding incurring VHNDs were included as household level covariates.

4.2.3 Statistical analysis

Descriptive analysis of respondents' characteristics and the distribution of DPT3 immunization across other covariates were explored as number and percentages. This study implemented multilevel mixed effect logistic regressions accounting for the hierarchical nature of the data. DPT3 immunization of individual children was considered as level 1; households were considered as level 2 and GPs were

considered as level 3. First, the effect of each individual, household and community level covariates on DPT3 immunization status were independently estimated. All social capital measures and covariates which presented a p-value ≤ 0.2 in the bivariate multilevel mixed effect logistic models were included in the multivariate regressions (Maldonado & Greenland, 1993). To estimate the adjusted fixed effect of social capital on DPT3 immunization, six multilevel mixed-effect logistic models were fitted to the data considering household and community as random intercepts. The first model (*Model 1*) was a null model without any covariate. This baseline model decomposed the total variance of DPT3 immunization between households and GP level. The second (*Model* 2) and third (*Model* 3) models were extended by including standardized factor scores of social capital of mothers and household heads at the individual level and the community level accordingly. *Model* 4 comprised of all the covariates of *Model* 3 and additionally included covariates related to the child, mothers and the household heads. *Model* 5 and *Model* 6 were expanded by sequentially adding household and community level covariates. In addition to these six models, we have tested several models including cross-level interaction terms – (1) between statistically significant community-level social capital variables with its individual-level counterpart and (2) between statistically significant social capital measures with other significant covariates. As mother's age did not present a linear association with DPT3 immunization, the regression model included spline terms for mother's age (< 21years and ≥ 21years). Within the analytical sample, standardized factor scores of individual *Organizational participation* and *Social support* presented a high correlation for both household heads and mothers. Thus, among these two social capital constructs, we only included individual *Organizational participation* in the regression models to prevent multicollinearity. The measures of variation of DPT3 immunization (random-effect) was reported using the estimated random intercept of the cluster, variance (σ^2) and Intracluster Correlation (ICC) of the household and community level.

We used the Akaike information criterion (AIC) to assess the goodness of fit of the model, and multicollinearity of the covariates was examined by the variance inflation factor (VIF). Additionally, we

explored the generalized residuals (Pearson, deviance, and Anscombe residuals) extracted from our final model (*Model 6*). To generate the factor scores of social capital constructs MCFA models were implemented using Mplus 8.1 (Muthén & Muthén, 2017). Data management, descriptive analysis, and regression analysis to assess the association between social capital and DPT3 immunization were performed using Stata 15.1 (StataCorp, 2017).

4.3 Result

4.3.1 Descriptive statistics

The analysis included 2,239 children aged 12-59 months (level 1), residing in 1,749 households (level 2), nested within 346 communities (level 3). Table 4.2 presents the descriptive statistics of 12-59 months old children and their associated households and communities (PSUs). In the study sample, 57% (n= 1,282) children have been immunized by DPT3 vaccine, and among the subpopulation of 12-23 month children (n= 533), 67% (n= 358) received DPT3 vaccine at the time of the survey. About 70% of children whose mother had educational attainment higher then primary level received DPT3 vaccine compared to 53% of children whose mother are illiterate. Among the children who received DPT3 immunization, 86% (n = 1,102) belonged to Hindu households, 47% (n= 598) were from scheduled caste and scheduled tribe, and 28% (n = 365) were from highest socioeconomic status.

Table 4.2: Demography of children between 12-59 months in two districts of UP, India (N = 2,239)

Individual-level Characteristics	**Children between 12-59 months who received three doses of DPT vaccination before 12 months (n = 1,282)**		**Total number of children between 12-59 months (n = 2,239)**
	n	%	n
Children's age category			
12-23 month	358	67%	533
24-35 months	345	63%	544
36-47 months	330	56%	594
48-59 months	235	47%	501
Birth Order			
Firstborn	1,016	57%	1,781
Not firstborn (Second/third/fourth born)	252	64%	391
Children's gender			
Boy	661	59%	1,113
Girl	621	59%	1,058
Facility where most of the vaccinations were received			
AWC or VHND	758	63%	1,194
Sub-Centers	326	65%	499
PHC, CHC or Hospital	177	62%	284
Mother's education			
Illiterate	572	53%	1,086
Up to Primary	318	61%	519
Above Primary	387	70%	556

Individual-level Characteristics	Children between 12-59 months who received three doses of DPT vaccination before 12 months (n = 1,282)		Total number of children between 12-59 months (n = 2,239)
Mother's occupation			
Unemployed/Housewife	1,215	59%	2,058
Employed	62	60%	103
Household Head's education			
Illiterate	516	59%	875
Up to Primary	307	57%	536
Above Primary	459	60%	761
Household Head's occupation			
Cultivator	693	61%	1141
Wage laborer	250	54%	462
Salaried Worker	170	61%	279
Unemployed	169	58%	290
Religion			
Hindu	1,102	57%	1,930
Muslim and Others	180	58%	309
Caste			
General	205	59%	348
Schedule Caste and Schedule Tribe	598	58%	1,028
Other Backward Caste and Others	479	56%	863
Wealth Quintile			
Quintile 1	168	53%	320
Quintile 2	196	59%	335
Quintile 3	266	59%	453
Quintile 4	287	54%	529
Quintile 5	365	61%	602
District			
Hardoi	647	57%	1,132
Sitapur	635	57%	1,107
Total	**1,282**	57%	**2,239**

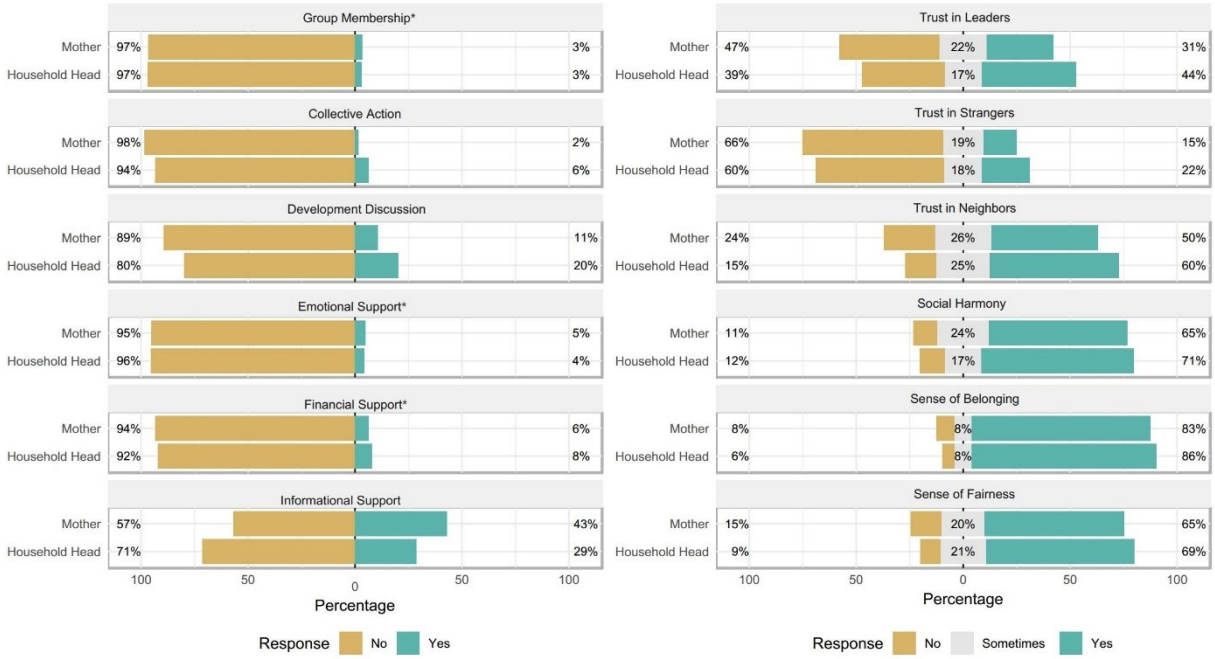
Note: % column represents the proportion of 12-59 months who received three doses of DPT vaccination before 12 months among the sub-sample (row percentage)
AWC= Anganwadi Center, CHC = Community Healthcare Center, FLW = Front Line Health Workers, PHC = Primary Healthcare Center

At level 2, households where children aged 12-59 months resided were mostly Hindu (86%, n= 1,498), belonged to scheduled caste and scheduled tribe (46%, n= 796) and from Quintile 5 (27%, n= 472). Sampled PSUs were equally distributed among Hardoi and Sitapur district with the highest number of PSU situated in Behadar block (n= 70) .

Figure 4.2 presents the distribution of the 12 social capital indicators among household heads (n = 1,749) and mothers (n = 1,779) of 12-59-month-old children. The positive (yes) responses for structural social capital indicators ranged from 3% (*group membership)* to 36% (*informational support)*. *Group*

membership, *emotional,* and *financial support* did not present any statistically significant difference between the household heads and mothers (χ^2 p-value > 0.05). Cognitive social capital related indicators had much higher positive (yes) responses ranging from 18% (*trust in strangers*) to 85% (*social belonging*) and all were significantly different across the household heads and mothers.

Figure 4.2: Distribution of social capital indicators of household heads (n = 1,749) and mothers (n = 1,779) of 12-59-month-old children in UP, India



Note: * = Indicators which did not present any significant different between household head and mothers of 12-59 month of child in Chi-square difference tests at the significance level 0.05

4.3.2 Measures of association

Table 4.3 presents the unadjusted odds ratios and adjusted odds ratios (AOR) between DPT3 immunization and explanatory covariates. After adjusting for individual, household and community level covariates, at the individual level, only *Organizational Participation* of the mothers presented a significant association with a child's likelihood of receiving DPT3 immunization in the final model (*Model* 6). Within a given community, a child's odds of being immunized by DPT3 vaccine reduced by 18% (AOR = 0.82, 95% confidence interval [CI] = 0.66-0.99; p = 0.046) with each additional standard deviation (SD) increase in individual *Organizational Participation* of the mothers. Among the community

level social capital constructs, mothers *Organizational Participation* and *Social Cohesion* significantly improved the odds of DPT3 immunization in *Model* 6.

Table 4.3: Comparison of three-level mixed-effect models for fixed and random-effect estimates for DPT3 immunization among children between 12-59 months in two districts of UP, India

	Unadjusted	M1	M2	M3	M4	M5	M6
Fixed effects	**COR**	**AOR**	**AOR**	**AOR**	**AOR**	**AOR**	**AOR**
Individual social capital							
Mother's organizational participation	1.02		0.98	0.89	0.81*	0.81*	0.82*
Mother's social support	0.99						
Mother's trust	1.13¥		1.09	0.94	1.04	1.03	1.05
Mother's social cohesion	1.11¥		1.06	1.17	1.10	1.11	1.10
Household head's organizational participation	1.02		1.10	1.12	1.11	1.10	1.07
Household head's social support	1.04						
Household head's trust	0.87¥		0.92	1.01	1.02	1.03	1.02
Household head's social cohesion	0.88¥		0.90	0.85	0.84	0.83	0.87
Community social capital							
Mother's organizational participation	1.03			1.39*	1.33	1.32	1.47*
Mother's social support	0.85¥			0.79	0.73*	0.73*	0.78
Mother's trust	0.85¥			0.85	0.86	0.86	0.86
Mother's social cohesion	1.18¥			1.65***	1.65**	1.63**	1.72***
Household head's organizational participation	1.02			1.04	1.05	1.04	1.00
Household head's social support	0.96			0.95	0.99	0.98	0.96
Household head's trust	0.89¥			0.83	0.82	0.82	0.86
Household head's social cohesion	0.98			0.99	0.98	0.96	1.04
Child's characteristics							
Age categories (Ref- 48 to 59 months)							
12 to 23 months	5.05***				4.00***	4.04***	4.46***
24 to 35 months	3.73***				3.36***	3.38***	3.64***
36 to 47 months	1.90**				1.86**	1.86**	1.96**
Birth order (Ref- Firstborn)							
Not firstborn (second/third/fourth)	2.26***				1.10	1.10	1.06
Gender (Ref- Boy)							
Girl	0.95						
Facility for vaccination (Ref- AWC/VHND)							
Sub-centers	0.92						
PHC, CHC or Hospital	0.71						
Mother's characteristics							
Age 15-21 (Year)	1.14				1.21	1.22	1.26

	Unadjusted	M1	M2	M3	M4	M5	M6
Fixed effects	**COR**	**AOR**	**AOR**	**AOR**	**AOR**	**AOR**	**AOR**
Age 22-49 (Year)	0.92***				0.96**	0.96*	0.96**
Education (Ref-Illiterate)							
Up to primary	1.86***				1.64*	1.62*	1.63*
Above primary	3.32***				2.47***	2.45***	2.52***
Occupation (Ref-Unemployed)							
Employed	0.86						
Number of immunization information source	1.51***				1.45***	1.44***	1.40***
Regular communication with FLWs (Ref- No)							
Yes	1.74***				1.36	1.34	1.40*
Knew about incurring VHNDs (Ref- No)							
Yes	1.44***				1.29	1.27	1.28
Freedom of decision making (Ref- No freedom at all)							
Freedom in very few decisions	1.66*				1.45	1.39	1.33
Freedom in some decisions	1.63*				1.55	1.50	1.46
Freedom in most decisions	1.04				1.03	0.97	0.96
Freedom in all decisions	1.26				0.95	0.90	0.91
Household Head's characteristics							
Age (Year)	1.00						
Marital status (Ref- Single/ Widowed/Divorced)							
Married	1.56*				1.69*	1.67*	1.64*
Education (Ref- Illiterate)							
Up to primary	0.99						
Above primary	1.16						
Occupation (Ref- Cultivator)							
Wage laborer	0.80						
Salaried worker	1.16						
Unemployed/Student/Housewife	0.94						
Number of immunization information source	1.09¥				1.04	1.05	1.01
Household's characteristics							
Household Size (Member Number)	0.95¥					0.96	0.96
Religion (Ref- Hindu)							
Muslim and Others	1.15						
Caste (Ref- General)							
Scheduled Caste/Scheduled Tribe	0.92						
Other backward caste and others	0.83						
Household wealth (Ref- Quintile 1)							
Quintile 2	1.71*					1.50	1.50

	Unadjusted	M1	M2	M3	M4	M5	M6
Fixed effects	**COR**	**AOR**	**AOR**	**AOR**	**AOR**	**AOR**	**AOR**
Quintile 3	1.46					1.42	1.44
Quintile 4	1.15					0.99	1.02
Quintile 5	1.66*					1.54	1.57
Household financial stability (Ref- Worsen)							
Stable or Improved	1.19						
Community characteristics							
Census Block (Ref- Behadar)							
Kachhauna	1.10						
Kothwan	0.70						
Kasmanda	0.75						
Machhrehta	1.29						
Sidhauli	0.86						
Community-level proportion of scheduled caste population	1.17						
Community wealth	1.37**						1.32**
Community average age of children (Months)	1.03¥						1.04*
Community average mothers' education	1.69*						0.70
Community average of immunization knowledge	1.25**						1.13
Improvement of the health service (Ref- No)							
Yes	1.02						
Presence of active VHSNC (Ref- No)							
Yes	1.66**						1.66*
Random effects							
Level 3: Community level variation (variance)		1.25	1.19	1.08	1.17	1.20	0.96
ICC		0.17	0.17	0.16	0.16	0.17	0.14
Level 2: Household level variation (Variance)		2.63	2.41	2.38	2.90	2.74	2.84
ICC		0.54	0.52	0.51	0.55	0.55	0.54
Observations		2239	2228	2228	2161	2161	2161
Log-likelihood (LL)		-1461	-1450	-1440	-1356	-1303	-1291
Akaike information criterion (AIC)		2928	2919	2915	2682	2685	2670

Note: *** = p < 0.001, ** = p < 0.01, * = p < 0.05, ¥ = p < 0.2, COR = Crud odds ratio, AOR= Adjusted odds ratio

There are total 2,239 children between the age of 12-59 months whose DPT3 immunization status was reported from 1,749 households within 346 Gram Panchayats or primary sampling units (PSU)

M1 = Model with no covariates, M2 = Model with individual social capital, M3 = Model with covariates of Model 2 and community social capital, M4 = Model with covariates of Model 3 and child, mother and household head covariate, M5 = Model with covariates of Model 4 and household's characteristics, M6= Model with covariates of Model 5 and community level covariates

AWC= Anganwadi Center, CHC = Community Healthcare Center, FLW = Front Line Health Workers, ICC = intra-class correlation, PHC = Primary Healthcare Center, VHND = Village Health and Nutrition Day, VHSNC = Village Health Sanitation and Nutrition Committee

After controlling for all covariates, comparing two communities that differ by one SD of mother's *Organizational Participation*, a child from the community with higher *Organizational Participation* had 47% higher odds (AOR = 1.47, 95% confidence interval [CI] = 1.09–2.00; p = 0.013) than a child from the other community. And, between two communities that differ by one SD of mother's *Social Cohesion*, a child living in the community with higher *Social Cohesion* had 72% higher odds (AOR = 1.72, 95%CI = 1.27–2.32; p < 0.001) compared to the community with lower *Social Cohesion*, after adjusting for all covariates.

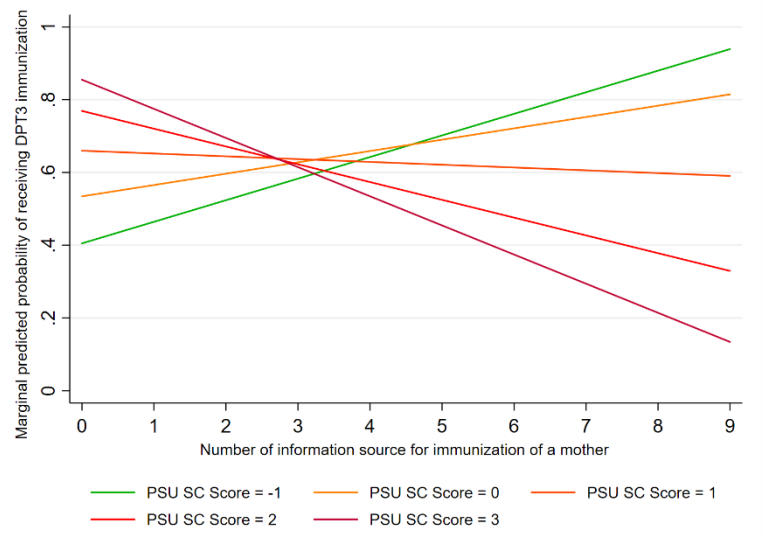
The strongest association was observed for the mother's education and the age category of the child. After adjusting for individual, household, community level variables and random effects, a child whose mother attained primary educations had 63% (AOR = 1.63, 95%CI = 1.10–2.41; p = 0.015) higher odds and a child whose mother attained above primary education had 151% (AOR = 2.51, 95%CI = 1.62–3.89; p < 0.001) higher odds of being immunized by DPT3 compared to a child of an illiterate mother. We observed an increasing trend of odds of a child being immunized among the younger cohort compared to the older children. Considering the 48-59 month children as reference category, children between 12 to 23 months had 4.6 time (AOR = 4.62, 95%CI = 2.86–7.56; p < 0.001) higher odds of receiving DPT3 vaccine. In *Model* 6 – among other covariates – the spline term of mothers' age above 21 years presented a negative association with DPT3 immunization at the level of p <0.05. On the other hand – adjusting for all confounders – higher number of immunisation information source reported by the mothers, regular communication of the mothers with the community health workers, household head being married, higher community wealth and presence of active VHSNC were significantly associated with higher likelihood of a child being immunized by DPT3 vaccine (p <0.05).

Cross-level interaction between the social capital measures did not present any significant interaction with DPT3 immunization status of the children (Data is not shown, see Appendix 8). However, we identified two significant cross-level interactions between social capital measures and other covariates. First, the interaction was between community-level *Social Cohesion* of the mothers and the

individual mother's knowledge of immunization (measured by the number of sources from where a mother received information on childhood immunization).

This interaction presented a negative correlation with DPT3 immunization (AOR = 0.73, 95%CI = 0.61–0.87; p < 0.001) indicating a heterogeneous effect of community-level *Social Cohesion* of the mothers (Figure 4.3). In a community where mothers *Social Cohesion* was low (green line, spwsc= -1) higher knowledge of immunization benefited a child, compared to a community where mothers *Social Cohesion* was high (brick red line, spwsc= -3) higher knowledge of a mother regarding immunization was associated with reduced odds of child immunization.

Figure 4.3: Relationship between an individual mother's knowledge of immunization and the predicted probability of a child receiving DPT3 immunization across different level of community-level social cohesion of mothers



Note: PSU SC Score = standardized factor scores of community (PSU) level social cohesion of mothers

The second cross-level interaction was observed between community wealth and individual mother's *Organizational Participation* (AOR = 1.23, 95%CI = 1.24–1.47; p < 0.019) (Figure 4.4). In the wealthiest communities (brick red line, PSU wealth score = 4), we observed individual *Organizational participation* of the mothers had a positive association with a child's odds of receiving DPT3 immunization. Whereas in the opposite spectrum, this association was negative in the poorest communities.

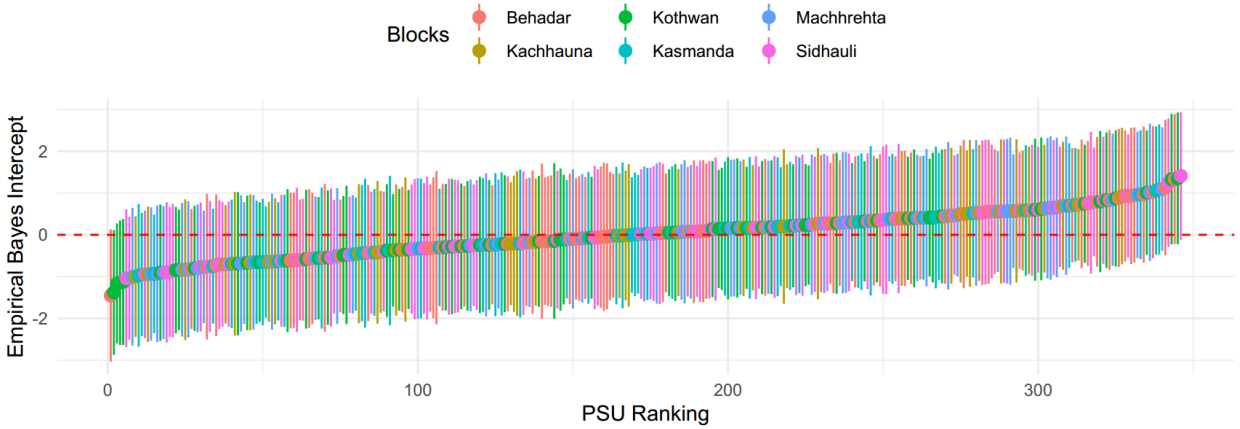
Figure 4.4: Relationship between mother's individual-level organizational participation and the predicted probability of a child receiving DPT3 immunization across different level of community wealth

Note: PSU Wealth Score = Standardized score of the average asset index of all household in the community (PSU)

4.3.3 Measures of variation

Though there was substantial variability in the PSU level random intercepts, none of them were statistically different from zero. Figure 4.5 depicts the distribution of the random intercept of the PSUs.

Figure 4.5: Distribution of the PSU level random intercept (n= 346) with a 95% confidence interval across six census blocks of two rural districts in UP



Note: The estimated value of the PSU level random intercepts and their standard errors were estimated by best linear unbiased predictors (BLUPs) or Empirical Bayes estimates after running the adjusted mixed effect logistic regression (*Model* 6). The solid circle represents the adjusted estimate of random intercepts and the vertical bars indicate 95% confidence interval of the estimate

The baseline model (*Model* 1) presented significant variability in the odds of being immunized by DPT3 vaccine between community (σ^2 = 1.25, 95%CI = 0.80–1.98) and across households (σ^2 = 2.63, 95%CI = 1.57–4.40). Implementation of multilevel models for this analysis was appropriate as household and community levels were able to explain 54% and 17% variance in the odds of a child's DPT3 immunization status accordingly (ICC presented in Table 4.3). Including the individual social capital constructs of mothers and household heads in *Model* 2 reduce the variance of DPT3 immunization by 8% at the household level and 5% at the community level. The variation of DPT3 immunization remained significant in *Model* 3 (community σ^2 = 1.08, 95%CI = 0.67–1.73; household σ^2 = 2.38, 95%CI = 1.38–4.10), with a 10% reduction in community-level variance when we included community-level social capital constructs in the model. In the final model (*Model* 6) household level presented a variance of 2.83 (95%CI= 1.57–5.10) and community level variance was reduced to 0.96 (95%CI= 0.54–1.70). Conditional on the fixed-effects covariates at all three levels, *Model* 6 presented a total ICC of 68% (household 54% and community 14%) and with a 1.55% cumulative reduction at the household level and 18.60% at the community level from the baseline model (*Model* 1).

The mean VIF value of *Model* 6 was 2.07, and none of the covariates presented a VIF value > 10. As indicated in Table 4.3, in every step of expanding the baseline model, the AIC values were decreased subsequently, with the lowest value reported for *Model* 6. This indicates that *Model* 6 had the best goodness of fit for this analysis.

4.4 Discussion

4.4.1 Discussion of the result

Based on the result of the analysis, 57% of children between 12-59 months and 67% of children between 12-23 months received all three doses of DPT vaccine before the age of 12 months. Similar estimates were found in the latest National Family Health Survey of 2015 which reported the coverage of DPT3 immunization was 66.5% among children aged 12-23 months in UP (International Institute for Population Sciences & ICF, 2017). Social capital presented a robust and significant association with DPT3 immunization at the community level. A substantial portion of the variability in the odds of DPT3 immunization (71%) was accounted for household and community random intercepts using multilevel regression models.

After adjusting for confounders at the individual, household, and cluster level, individual *Organizational Participation* of a mother presented a negative association with DPT3 immunization of a child. While this was an interesting finding, Silva & Harpham (2007) in India and Harpham et al. (2006) in Vietnam also found similar negative result while exploring the influence of social capital on the nutritional status of children. Cross-sectional data do not allow us to infer – if time and opportunity cost of *Organizational Participation* of a mother negatively impacted the likelihood of a child being immunized, or mothers who could not utilize the vaccination service were more willing to participate in social activities seeking instrumental supports.

However, an alternative explanation can be found from the work of Nancy Folbre (1994). According to her, the responsibility of child-rearing often imposes structural constraints for social interaction. Munch and colleagues (1997) empirically investigated this phenomenon both among men and women. They explained, during childrearing years women's social network shrinks in size as they need to invest more time on the child, whereas for men childrearing temporarily increase their social network by connecting them with their family members. Reduction of the size of social network for women often

affects their ability to engage in community activity effectively. From this perspective, the relationship between DPT3 immunization and individual mother's *Organizational Participation* appears to be spurious, as the event of childrearing is proposed to be the precursor of reduced *Organizational Participation* – yet, cross-sectional data do not allow us to infer any causal association. However, while exploring the interaction between community wealth and *Organizational Participation*, we found the role of *Organizational Participation* of an individual mother was much more nuanced.

Despite having an independent negative association with DPT3 immunization, *Organizational Participation* of an individual mother acted as an effect modifier for community wealth. We observed a heterogeneous effect of *Organizational Participation* of an individual mother, indicating more affluent community might provide an enabling environment for a mother to engage in *Organizational Participation*. Participating in community groups or in collective action, *Organizational Participation* of a mother who lives in a wealthy may have a synergistic effect to build an enabling setting to utilize immunization services for her child by connecting with heterogeneous groups of people, resources and information (Islam et al., 2006). Whereas, poor socioeconomic status of the community is disinvestment in social capital. Living in an environment with economic and social deprivation, the time and opportunity cost for social engagement with the community vs. prioritizing your own family may lead to a zero-sum game (Kawachi et al., 2008).

Our study also found that community-level *Organizational Participation* and *Social Cohesion* of the mothers were positively associated with DPT3 immunization. This finding corroborates with other studies which supported the contextual effect of social capital on immunization (Jung, Lin, & Viswanath, 2013; Story, 2014) and other health outcomes such as smoking and drinking (Chuang & Chuang, 2008), self-reported mental health (Hamano et al., 2010) and self-rated health (De Clercq et al., 2012; Mohnen, Groenewegen, Völker, & Flap, 2011). Will Story (2014) used multilevel analysis to show that civic participation in social organizations such as women's groups, self-help groups, credit or savings groups was associated with higher immunization of children in India. However, he defined the idea of civic

participation as intergroup bridging capital. While not in the context of routine immunization, during Influenza A or H1N1 pandemic, a higher level of volunteering and associational membership in the community had a significant and robust association with H1N1 immunization coverage rates in America and Taiwan (Chuang, Huang, Tseng, Yen, & Yang, 2015; Rönnerstrand, 2014). In the context of rural UP where immunization program is being implemented by the support of health committee (VHSNCs), a higher level of collective *Organizational Participation* of the mothers may lead to effective use of social network and support system ensuring utilization to immunization service for everyone.

This study showed that children who lived in communities with higher social cohesion among their mothers had higher odds of having all three DPT vaccine. In a study by Kim & Kawachi (2017), neighborhood social cohesion found to have a positive effect on preventive healthcare behavior such as immunization. This positive association with DPT3 immunization may suggest a classical pathway of social capital at work – performing coordinated action for the common good. Like previous examples, the positive influence of cohesiveness of the community in India was also found for consistent condom use (Fonner et al., 2014; Kuhlmann, Galavotti, Hastings, Narayanan, & Saggurti, 2014), social wellbeing (Sohi, Singh, & Bopanna, 2018) and recovery from natural disaster (Nakagawa & Shaw, 2004).

However, interacting with a mother's knowledge of immunization, the collective *social cohesion* of the mothers in a community presented an antagonistic effect on DPT3 immunization. While the independent association between knowledge of immunization of the mother and DPT3 immunization was positive, for those communities where the collective *social cohesion* of the mothers was high, this association gradually attenuated and then moved towards negative (Figure 4.3). This can be explained by the power of informal social control of a highly cohesive community. The existing social norm and values of a tightly bonded community often restricts the access of outside information or discourages its members adopting new behaviors (Vikram et al., 2012).

4.4.2 Strengths and limitations of the study

This is the first study - specific to UP - exploring the association between social capital and service utilization for DPT3 immunization. Utilizing the strength of multilevel analysis, we were able to distinguish the influence of individual and community level social capital and other covariates on immunization which is not possible by conventional regression method (Duncan, Jones, & Moon, 1998). To assess the social capital, we have used a validated scale which was further adapted using the rapid cognitive interviewing technique. In addition, the MCFA technique was implemented to generate a valid measure of latent constructs like social capital (DeVellis, 2016).

Having a strong theoretical underpinning and a comprehensive conceptual framework derived from WHO's CSDH framework are the strengths of this study. We have included a vast array of confounders related to social structure, socio-political context, behavior, knowledge, psychosocial factors, and health system related predictors at the individual child, household and community level. To the best of our knowledge, this is the only study which simultaneously included social capital measures of mothers and household heads to explore health-related behavior in the household and community.

However, the result of this study must be interpreted considering its limitations. We only explored the correlation between social capital and DPT3 immunization and any causal inference cannot be made due to the cross-sectional nature of the data. The study measured the current social capital of the respondents. However, the questions related to the immunization status of the child were related to the past five years preceding the survey. During the survey, mothers of 43% (n=962) of the 12-59 month children were able to reproduce the immunization cards. Similar to other low and middle-income countries, retention of immunization card, data recording and reporting of immunization are systemic problems in India (Fatiregun & Etukiren, 2014; Lahariya, 2014). Thus, we substituted self-reported data for those children who did not have an available immunization card - which is the current standard of analysis (International Institute for Population Sciences & ICF, 2017). A counterargument against this decision can be the introduction of recall bias from a mother's reporting. However, excluding the self-

reported data often lead to sample attrition and overestimation of the immunization coverage (Babalola, 2009). Also, our estimated proportion of children who were immunized by DPT3 closely resembles the state-level prevalence of UP (International Institute for Population Sciences & ICF, 2017).

Due to the limitation of data availability we were not able to account for all possible covariates which can explain the variability of DPT3 immunization. Institutional delivery, antenatal and postnatal care are few of the health care utilization pattern which are strong predictors of DPT3 immunization (Sridhar et al., 2014). Beyond the individual and household level predictors, other systemic factors and social context affects the community-level variation of immunization. These factors include, but not limited to, public health policy, healthcare financing, and governance, motivation, and performance of the healthcare providers, civil unrest, etc.

4.5 Conclusion

In conclusion, the result of this study can significantly contribute to understanding the immunization service utilization in rural UP and further advancing the literature of social capital in India. In the descriptive analysis of indicators related to the *organizational participation* we found the level of social participation by mothers was very low (Figure 4.2). VHSNCs and other government and private sector-led self-help groups provide some opportunities for women to participate in organizational activities in rural UP. However, these social structures often fail to utilize their gender transformative potential and unable to empower the women due to the rigid social norm and power relations within the communities (Sahu, 2015; Scott, George, Harvey, Mondal, Patel, & Sheikh, 2017). Despite these challenges, this study indicated a positive association between community-level *Organizational Participation* of mothers and the immunization of children. This indicates an opportunity for a positive change if all the mothers in the community come together. Development programs and research on women empowerment and gender equality have consistently shown their impact on better health and wellbeing of the community (Taukobong et al., 2016). Thus, it is necessary to provide opportunities to mothers - and women at large - in the communities to effectively participate in social groups, collective action and in the discussion for collective development. None of the social capital constructs related to household heads – who were mostly men – had any significant association with immunization outcome. However, the importance of including men to promote maternal and child health has been recognized and advocated worldwide including India (Chattopadhyay, 2012; Tokhi et al., 2018). We recommend further research on social capital, possibly with longitudinal data and in-depth qualitative exploration to understand these phenomena.

Historically, the central government of India and the state government of UP strived to develop cohesiveness and solidarity for promoting health and equality in a unique caste-based social structure. Looking into the chronology of health sector reform in UP, building a primary care system integrated within the community to reduce the barriers for access, utilization and healthcare cost were the central

strategy of NHM (Rao, Arora, & Ghaffar, 2014) and the recently approved National Health Policy of India (Ministry of Health & Family Welfare, 2017). However, underneath the social tapestry, gender and caste-based discriminations restrict people to avail these benefits (Scott, George, Harvey, Mondal, Patel, & Sheikh, 2017; Singh, 2016). The scope of this paper does not allow us to provide any specific recommendation to improve *Organizational Participation* or *Social Cohesion* in rural India, nor there is any cookie cutter solution to build social capital in any context. It is essential to acknowledge that social structure, norms, and relationships are unique in each community even within a state. Moreover, building social cohesion will have significant positive externalities on the overall health and wellbeing of the rural community of UP, India.

5. Social capital, social influence and tobacco consumption in rural Uttar Pradesh, India

Abstract

India has the world's second-largest tobacco consuming population, and a 6% decline in prevalence was observed in the six years since 2010. Beyond individual behavior, social environment and relationships between individuals and communities often influence tobacco use. Integrating social cognitive and social capital theory, this study explored the role of social capital and social influence on tobacco consumption among household heads in rural Uttar Pradesh (UP), India.

Data from a community-based cross-sectional survey were used to estimate self-reported tobacco use among 6,218 household heads (≥18 years) from two districts of UP. Multilevel confirmatory factor analysis was used to measures four uniquely identified components of social capital (*Organizational Participation*, *Social Support*, *Trust* and *Social Cohesion*) both at individual and community levels. The social influence of tobacco consumption was measured by "non-self" cluster proportion of tobacco use in the community. The explanatory power of the covariates on tobacco consumption was assessed using generalized linear (logistic) models with Huber/White/sandwich robust variance estimator.

In this sample, 63% of household heads consumed any tobacco products. In the adjusted model, only individual organizational participation was significantly associated with tobacco use (Adjusted odds ratio [AOR] = 1.06, 95%CI: 1.01-1.13, $p < 0.05$). Adjusting for all covariates, a 10% increase in social influence was associated with a 10.3% increase in tobacco consumption's odds (95%CI of AOR: 1.10, 95%CI: 1.05-1.16, $p < 0.01$).

The majority of household heads consuming tobacco may provide enabling social cues to others believing it is normative behavior. Beyond the effect of social influence, organizational participation had an independent association with tobacco consumption. We suggest further exploration of the causal effect of social influence and participation on tobacco use. Moreover, acknowledging the limitation of cross-sectional data, we recommend synergizing the current tobacco control efforts with community-based participatory interventions to denormalize tobacco consumption in rural UP.

5.1 Introduction

According to the World Health Organization (WHO), in 2016 globally more than 1.1 billion people smoked tobacco, and 80% of them are living in low and middle-income countries (LMICs) (Commar, Prasad, Tursan d'Espaignet, Wolfenden, & World Health Organization, 2018). Tobacco use is one of the leading causes of mortality and morbidity, and its effect on the global burden of disease is on the rise (Forouzanfar et al., 2016). Having 266 million current tobacco users (21.4% smokeless and 10.7% smoked tobacco), India ranks second in tobacco consumption in the world (Ministry of Health and Family Welfare, Government of India & Tata Institute of Social Sciences, 2017). Fifteen years since India signed WHO's Framework Convention on Tobacco Control (FCTC) and five years after adopting a national action plan and monitoring framework for prevention and control of NCDs, progress at reducing tobacco use is still slow (Government of India & World Health Organization, 2013; Ministry of Health and Family Welfare, Government of India & Tata Institute of Social Sciences, 2017; World Health Organization & Bloomberg Philanthropies, 2017). The national action plan and monitoring framework set a goal of a 15% relative reduction of tobacco use by 2020. However, a 6% decline of tobacco use was observed in India in the six years since 2010 (Ministry of Health and Family Welfare, Government of India & Tata Institute of Social Sciences, 2017).

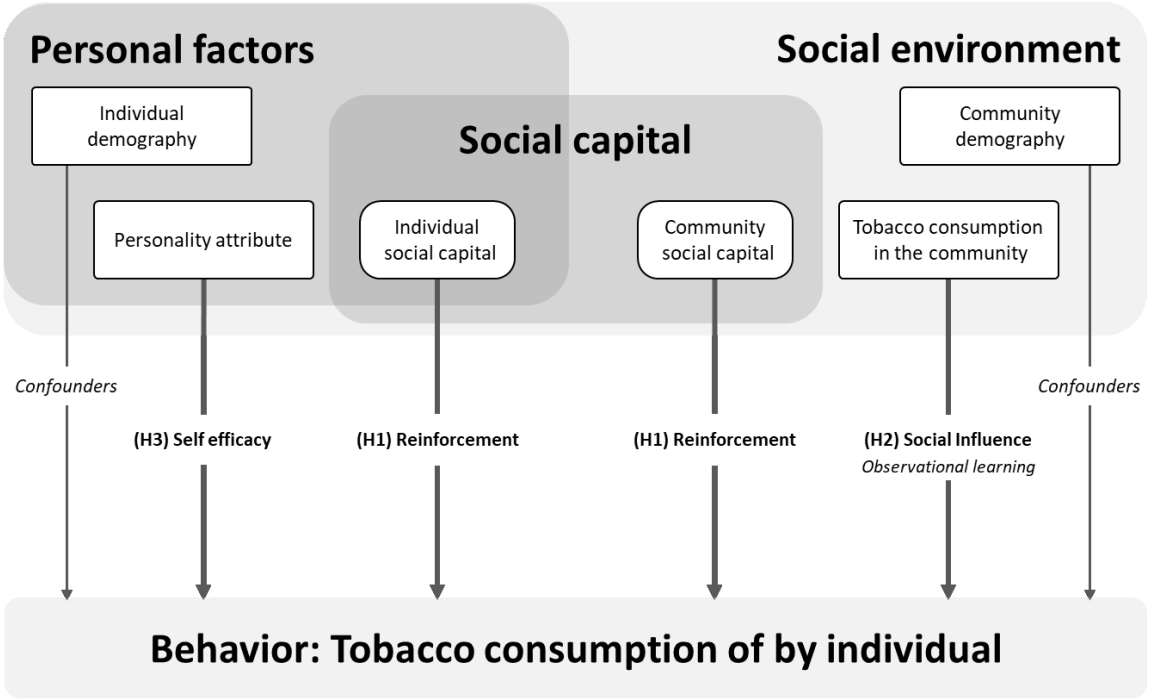
The use of smoked or smokeless tobacco is individual behavior. However, the adverse effect of this non-communicable disease (NCD) related health behavior extends beyond individual and impacts population health resulting in high healthcare expenditure and loss of productivity (Jha & Peto, 2014). Similarly, determinants of tobacco consumption also exist beyond the individual's demography and psychosocial factors. Contextual factors of a community such as a relationship between individuals and groups – which is defined as their social capital (Putnam, 2000) – and social environment also affects tobacco usage (Lindström, 2008; McNeill, Kreuter, & Subramanian, 2006). However, there is no current evidence of how these contextual factors affect tobacco consumption in India. Integrating social cognitive

and social capital theory, this study aimed to examine the role of social capital and social influence on this NCD-related health behavior in rural Uttar Pradesh (UP), India.

5.1.1 Tobacco consumption, social capital, and social influence: Conceptualized by social cognitive theory

Proposed by Albert Bandura, the social cognitive theory (SCT) explains the process of acquiring and sustaining any behavioral pattern of an individual while acknowledging the critical interaction between a person, his/her behavior, and the social environment (Bandura, 1986). While not in India, the SCT was previously applied to understand tobacco consumption behavior and prevention strategies in the Netherlands and United States of America (Bricker et al., 2010; Van Zundert, Nijhof, & Engels, 2009). Using the theoretical perspective of SCT, our study examines the role of social capital and social influence on tobacco use based on the conceptual framework presented below (Figure 5.1).

Figure 5.1: Conceptual framework derived from social cognitive theory to examine the role of social capital and social influence on tobacco consumption



Similar to the SCT, the conceptual framework represents a triadic relationship between personal factors, social environment, and tobacco consumption behavior (Schwarzer & Luszczynska, 2005). Bandura (1998) explained four critical concepts which define this triadic relationship as self-efficacy, observational learning, outcome expectations, and reciprocal causation. Within our conceptual framework, we have theorized the first two concepts of SCT to explore tobacco consumption behavior. Self-efficacy means one's perceived ability to execute any behavior and in this study context consuming tobacco. According to Bandura, self-efficacy regulates human behavior by- (1) helping to cope with the stressor and (2) regulating their motivation and direct control over the behavioral pattern (Bandura, 1998). Thus, psychosocial factors (such as freedom of decision making, perceived power, perceived access, and happiness, etc.) can affect both mental state and everyday social interactions (Singh-Manoux, 2003; Upton, 2013). We conceptualized the psychosocial factors of an individual may affect the self-efficacy to use tobacco products.

Another fundamental premise of the SCT is observational learning from the social environment or through social influence. The causal relationship between health behavior and both the physical and social environment is well established (Bandura, 1986; McLeroy et al., 1988). Social environment affects individual behavior by "*...shaping norms, enforcing social control, enabling or not enabling people to participate in particular behaviors*" (Lindström, 2008). A person living in a community with higher tobacco use also has a higher likelihood of consuming tobacco due to social influence (Castro, Heck, Forster, Widome, & Cubbin, 2015; Kowalewska & Mazur, 2013; Nagler et al., 2015).

The conceptual framework integrates social capital as an intersectional construct between the individual and his/her social environment. Social capital signifies the characteristics of individual's and group's social network and relationship which includes trust, cohesiveness, social support, organizational participation, etc. (Putnam, 2000). This multi-dimensional and multi-level concept can act as both individual and community level construct and classified into structural and cognitive components (Harpham et al., 2002). Structural social capital signifies the associational link between individuals and

groups and represented by social/organizational participation and social support. On the other hand, the cognitive component of social capital embodies more subjective constructs such as trust, social cohesion, reciprocity, etc. (Kawachi et al., 2008).

WHO's Commission for Social Determinants of Health (CSDH) acknowledges social capital as a crosscutting social determinant of health and health-related behaviors (World Health Organization, 2010). As a social determinant, structural social capital plays an essential role by directly reinforcing an individual's behavior to access the resources of social network which can be further utilized to gain social support or promote the diffusion of information (Bourdieu, 1986b; Kawachi, Kennedy, & Glass, 1999). A cluster randomized controlled trial in Dutch schools found peer network as an effective strategy for smoking cessation. On the other hand, cognitive social capital can also affect health and health-seeking behavior (Crone et al., 2003). Construct-related to cognitive social capital such as the trust or social cohesion helps a person to align with the social norms which can lead to promotive or coercive health-related practice (Seid et al., 2015). A study from southern Sweden has shown a higher level of individual trust was negatively correlated with tobacco use (Lundborg, 2005). At a collective level, social capital enables the community to impose informal social control to establish practices prevalent in the community (Kawachi, 2010). However, there are only a handful of studies which explored community-level social capital and tobacco consumption, and most of them were in a school setting. In a large-scale econometric study in the USA, Brown et al. (2006) reported higher community social capital related to the religious group has a significant and negative correlation with the number of cigarettes consumed by smokers. Social capital can indirectly shape tobacco consumption behavior by influencing both psychosocial factors and the social environment (Karimzadeh, Ahmad, & Karimzadeh, 2013; Kawachi & Berkman, 2000; Lindström, 2004).

The population-based surveys on tobacco such as Global Adult Tobacco Survey (GATS) (Palipudi et al., 2016), Global Youth Tobacco Survey (World Health Organization, 2009) or WHO's STEPwise approach to surveillance (Riley et al., 2015) do not collect data on social capital. In a cultural

context where tobacco consumption is historically and culturally normalized (Mishra & Mishra, 2013), the current literature does not provide any evidence on the role of social capital or social influence as determinants of tobacco consumption in rural UP. Addressing the existing research gap on tobacco, the purpose of this study was to explore social capital and social influence as critical determinants of tobacco use among household heads in rural UP, India. Based on the conceptual framework (Figure 5.1), we are evaluating three potential pathways through which social capital and social influence affect individual tobacco consumption. First, social influence could be positively associated with tobacco consumption because the high level of tobacco use in the community may provide enabling social cues (*observational learning*) to other member believing tobacco use a social norm. Second, individual and community level social capital might be positively associated with tobacco consumption due to the *reinforcing effect* the social relations, which may enable tobacco use. And lastly, psychosocial factors of an individual are positively associated with tobacco consumption due to the regulating effect of *self-efficacy* on the motivation and direct control over smoking behavior.

5.2 Methods

5.2.1 Data source

Since 2016 researchers at the Johns Hopkins Bloomberg School of Public Health (JHSPH) have been collaborating with the HCL Foundation (HCLF) on a multisectoral rural development initiative, Project Samuday (HCL Foundation, 2017, 2018). The baseline survey of Project Samuday allowed JHSPH a unique opportunity to investigate different health-related behaviors and outcomes including tobacco consumption. The study area, six census blocks of Hardoi and Sitapur districts are rural communities, and the health and human development indicators of these census blocks are below the state average (International Institute for Population Sciences & Ministry of Health and Family Welfare, 2016).

The multi-stage cross-sectional household survey was conducted from June to August 2017 in 346 Gram Panchayats (GPs). GPs are constitutionally accredited rural governing bodies consisting of one to four villages (Ministry of Panchayati Raj & Government of India, 2017). In each GP, one community health workers, called Accredited social health activist (ASHA), is assigned to serve each 1,000 population (Government of India, 2018). The service area of a randomly selected ASHA from a GP was considered as primary sampling unit (PSU). After receiving informed verbal consent, trained data collectors interviewed 6,218 household heads (≥18 years). Information on tobacco use along with demographic, socioeconomic, psychosocial factors and social capital was collected using a computer-assisted personal interviewing system. The study received ethical approval from the Institutional Review Board Office of JHSPH and locally from Center for Media Studies, New Delhi, India.

5.2.2 Measurement and variables

Dependent variable

The outcome of this study is *"current use of any tobacco products"* including cigarettes, bidis or hukkah, chewing tobacco or gutkha (multiple were responses possible). Explanatory variables were

operationalized and classified into social capital, personal factors and social environment related covariates (Table 5.1). Detailed descriptions of the measurement of social capital, social influence, and other explanatory variables are provided in Appendix 9.

Table 5.1: Study variables

Dependent variables		
Consumption of any tobacco product (either smoked on non-smoked) by the household head		
Explanatory Variables		
Personal Factors	**Social Capital**	**Social Environment**
Individual demography	*Individual social capital*	*Community demography*
Age (in years)	Organizational Participation	Gram Panchayat Size
Gender	Social support	Community wealth [b]
Religion	Trust	Health service function
Caste	Social Cohesion	*Community tobacco consumption*
Marital Status	*Community social capital*	Scaled non-self cluster proportion of Tobacco use of the PSU [c]
Education	Organizational Participation	
Occupation	Social Support	
Household Size	Trust	
Household wealth (assets quintile)	Social Cohesion	
Psychosocial factors		
Freedom of decision making		
Perceived power		
Satisfaction with material circumstances		
Level of happiness		
Perceived accessibility [a]		

Note: a = Perceived accessibility was measured by household head's perception of improvement of village infrastructure service (e.g., roads, electricity, and water supply),
b = Community wealth is measured by the PSU average of standardized assets score derived from principal component analysis
c = Scaled no-self cluster proportion of tobacco use was generated by calculating the proportion of the household heads in the community (PSU) who consumed tobacco while excluding the respondent both from the numerator and denominator and then multiplying the proportion by 10. One unit increase in of this scaled indicator represents a 10% increase in "Non-self" cluster proportion of Tobacco use

Explanatory variables

Social Capital

Constructs of individual and community social capital were considered as the main explanatory variables in this study. To measure individual social capital, we used a modified version of the Adapted Social Capital Assessment Tool (SASCAT-I) (De Silva et al., 2006; Story et al., 2015b). The modified SASCAT included 13 questions exploring - group membership (2 questions), collective action (2 questions), social support (3 questions), trust (3 questions) and social cohesion (3 questions). From the household heads' response, 12 binary indicators were generated, and we implemented a multilevel

confirmatory factor analysis (MCFA) considering the PSU as level two. Four unique social capital factors emerged at each level and defined as *Organizational Participation*, *Social Support*, *Trust*, and *Social Cohesion*. Standardized factor scores of these constructs were considered as the measure of individual and community level social capital.

Personal factors

Individual demographic characteristics of the household heads and their psychosocial factors were considered as personal factors for the analysis. While exploring the determinants of tobacco use majority of the previous tobacco-related studies in India only included demographic covariates (Daniel, Nagaraj, & Kamath, 2008; David, Esson, Perucic, & Fitzpatrick, 2010; Rani, Bonu, Jha, Nguyen, & Jamjoum, 2003). Aligning with them, we considered self-reported gender, age, marital status, educational attainment, occupation, religion, caste, household size as demographic covariates. A household was considered as "large" if there were more than five members living in the house for the last six months and "small" otherwise. Household wealth was measured as a linear index generated using principal components analysis (PCA) of 27 binary indicators related to asset ownership (Filmer & Pritchett, 2001). Wealth quintiles of the households were generated from the index.

As an exploratory pool of psychosocial factors we considered freedom of decision making, perceived power, level of happiness, perceived accessibility and satisfaction with material circumstances of the household heads (Ataeiasl et al., 2018; Goldenberg, Danovitch, & IsHak, 2014; Institute of Medicine (US) Committee on Preventing Nicotine Addiction in Children and Youths, Lynch, & Bonnie, 1994; Tyrrell, Genin, & Myslinski, 2006) (See Appendix 9 for details). To understand satisfaction with material circumstances, we used a composite index generated by PCA of 19 binary variables related to household head's satisfaction towards minimum needs for food, clothing, accommodation, and other amenities. Perceived accessibility of the household head was measured by his/her perception of village infrastructure service by asking "*How has the functioning of infrastructure in your village (e.g., roads,*

electricity, and water supply) changed since last year?" (Response- Worsen, Stayed the same or Improved).

Social environment

Community demography and the level of tobacco consumption of the PSU were included in the analysis to account for the social environment by aggregating individual and household level data. Community wealth was derived by averaging the standardized PCA scores from all households of the PSU. The health service function of the community was measured by averaging the household heads' response to the question "*How has the functioning of government health services in your village changed since last year?*" Gram Panchayat size was also considered as community demography. Gram Panchayats were categorized into small, medium and large based on their population reported in the 2011 Census of India (Office of the Registrar General & Census Commissioner, 2011).

Aggregating individual data at the PSU level, the indicator of social influence was constructed as the "non-self" cluster proportion of tobacco use. This procedure is generally used in econometric modeling to account for the endogenous social effect (Babalola, 2007; Koku, 2011). This indicator was calculated as- the number of other household heads (excluding the respondent) residing in the PSU of the respondent who also consumed tobacco, divided by the total number of other household heads in the same PSU. To make the indicator more interpretable, we scaled it by multiplying the indicator by 10. Thus, one-unit change of the scaled indicator would represent a 10% change in "non-self" cluster proportion of tobacco use in the community. A significant association between the scaled indicator and the dependent variable would support the conclusion that social influence or the endogenous social process influence individual tobacco consumption behavior (McQuestion, 2003).

5.2.3 Statistical analyses

Data management and analysis were performed using Stata 15.1 (StataCorp, 2017). Mplus 8.1 was used to perform the multilevel CFA and generate individual and community level factor scores of

social capital (Muthén & Muthén, 2017). As an exploratory analysis, the proportion of household head smoking, chewing and using any tobacco products was reported across gender. Next, to understand the role of social capital on PSU level clustering of tobacco use, descriptive analysis of the intracluster correlation (ICC) of tobacco consumption was conducted. We stratified the respondents in quintiles of four individual social capital constructs using their standardized factor scores. The fifth quintile is considered as high and the first quintile as the low social capital category. Using logistic random-effects model and considering PSU level clustering we estimated ICCs of tobacco consumption for the total sample and all high and low social capital categories.

We assessed the explanatory power of each covariate by calculating unadjusted odds ratios with generalized linear regression models (logistic GLM). Next, multiple logistic GLMs were implemented to estimate the adjusted odds ratios of those covariates which represented a p-value ≤ 0.2 in the unadjusted models (Maldonado & Greenland, 1993). Based on the result of the adjusted model we further included additional interaction terms in a final model to identify any effect measure modification of explanatory covariates. We used the Huber/White/sandwich estimator to account for the within-cluster correlation of tobacco consumption by producing a robust variance. Age of the household head did not present a linear association with tobacco use. Thus the regression model included spline terms for this continuous covariate. Multicollinearity of the explanatory variables was assessed using the variance inflation factor (VIF). Wald tests were performed after running the regression models to estimate the overall significance of categorical variables. The goodness of fit and parsimony of the models were evaluated using the Hosmer-Lemeshow goodness-of-fit test and both Akaike information criterion (AIC) and Bayesian information criterion (BIC).

5.3 Results

5.3.1 Descriptive statistics

The respondents were predominantly male (85.4%, n = 5,312). Among the household heads, 62% (n = 3,884) reported using any tobacco product, 31% (n = 1,913) smoked, and 43% (n = 2,669) chewed tobacco products. In all three categories, a significantly higher proportion of men used tobacco compared to women household heads ($p < 0.01$). Table 5.2 presents the demographic characteristics of the respondents who consumed tobacco (n= 3,884) disaggregated by gender. Geographically, the proportion of household heads who consumed tobacco ranged from 59% (Machhrehta) to 66% (Kasmanda). 90% (n = 3,550) of the tobacco users were married; 37% (n = 3,884) were illiterate; 52% (n = 1,461) engaged in agricultural work and 48% (n = 1,878) were from scheduled castes or scheduled tribes. At the community (PSU) level, social influence, measured by the average "non-self" cluster proportion of tobacco use, was 63.7% which ranged from 12.6% to 100%. The community-level social capital constructs presented minimal correlation with the measure of social influence (*Organizational Participation* = 0.03, *Social Support* = 0.23, *Trust* = 0.06 and *Social Cohesion* = 0.16).

Table 5.2: Demographic characteristics of household heads who consumed tobacco by gender in two rural districts of UP, India (N= 6,218)

Variables	Household heads who consumed tobacco						All household heads (n = 6,218)
	Men (n =3,753)		Women (n = 131)		All (n = 3,884)		
	n	%	n	%	n	%	n
Type of tobacco product used							
Smoking	1,882	98%	31	2%	1,913	31%	6,218
Chewing	2,564	96%	105	4%	2,669	43%	6,218
Any type of tobacco use	3,753	97%	131	3%	3,884	62%	6,218
Age categories							
≤ 30 years	667	97%	21	3%	688	60%	1,143
31-40 years	1,044	97%	29	3%	1,073	68%	1,582
41-50 years	960	97%	27	3%	987	64%	1,539
51-60 years	637	95%	32	5%	669	61%	1,105
> 60 years	445	95%	22	5%	467	55%	849

Variables	Household heads who consumed tobacco						All household heads
	Men (n =3,753)		Women (n = 131)		All (n = 3,884)		(n = 6,218)
Marital Status							
Never married/Not stated	100	98%	2	2%	102	63%	163
Married	3,462	98%	88	2%	3,550	64%	5,509
Widow/Separated	191	82%	41	18%	232	42%	546
Education							
Illiterate	1,375	94%	86	6%	1,461	61%	2,394
Up to primary	1,028	98%	24	2%	1,052	68%	1,549
Up to secondary	1,069	98%	17	2%	1,086	65%	1,669
Above secondary	281	99%	4	1%	285	47%	606
Occupation							
Cultivator	2,036	100%	8	0%	2,044	69%	2,955
Wage laborer	1,175	98%	23	2%	1,198	70%	1,709
Self-employed & Others	310	99%	4	1%	314	68%	462
Salaried worker	93	95%	5	5%	98	51%	191
Housewife	0	0%	81	100%	81	13%	611
Unemployed	139	93%	10	7%	149	51%	290
Religion							
Hindu	3,358	97%	101	3%	3,459	62%	5,564
Muslim and others	395	93%	30	7%	425	65%	654
Caste							
General	583	95%	33	5%	616	56%	1,094
ST/SC	1,831	97%	47	3%	1,878	64%	2,938
OBC	1,339	96%	51	4%	1,390	64%	2,186
Assets quintile							
Quintile 1	746	95%	42	5%	788	63%	1,246
Quintile 2	788	97%	25	3%	813	65%	1,244
Quintile 3	794	98%	19	2%	813	66%	1,241
Quintile 4	750	98%	17	2%	767	62%	1,244
Quintile 5	675	96%	28	4%	703	57%	1,243
Community Level							
GP Size							
Small	1,311	97%	34	3%	1,345	64%	2,086
Medium	1,215	96%	57	4%	1,272	61%	2,071
Large	1,227	97%	40	3%	1,267	61%	2,061
Census blocks							
Behadar	753	97%	25	3%	778	62%	1,247
Kachhauna	422	97%	12	3%	434	60%	724
Kothwan	723	98%	17	2%	740	65%	1,132
Kasmanda	606	98%	14	2%	620	66%	936
Machhrehta	539	96%	25	4%	564	59%	956
Sidhauli	710	95%	38	5%	748	61%	1,223

Note: This table contains the descriptive statistics of the respondents who smoked, chewed or used any type of tobacco products across gender

The ICC for the total sample was 0.04 which implied only 4% of the overall variability of tobacco use was attributed to the similarity within the community. However, household heads in all high social capital categories (quintile 5) presented higher ICC compared to the low social capital (quintile 1) except

for *Trust* (Data is not shown, See Appendix 10). Household heads with high social cohesion presented highest (ICC = 0.10), and low organizational participation had the lowest clustering (ICC = 0.02).

5.3.2 Measures of association

Table 5.3 presents the results of the bivariate and multivariate logistic regressions models. In the bivariate or unadjusted models, tobacco use was significantly associated with most of the individual demographic characteristics and psychosocial factors at the level of $p<0.05$, except religion ($p = 0.18$) and satisfaction with material circumstances ($p = 0.06$). However, these covariates were still incorporated in the adjusted model as they presented the significance level below 0.2 (Maldonado & Greenland, 1993). None of the individual social capital constructs was independently associated with tobacco use. At the community (PSU) level, significant associations were observed for *Social Support* ($p < 0.01$) and *Social Cohesion* ($p = 0.01$). Along with these two community-level social capital constructs, individual *Organizational Participation* was included in the adjusted model as it presented the significance level below 0.2 (Maldonado & Greenland, 1993). Tobacco consumption was also significantly associated with community wealth ($p = 0.01$) and scaled "non-self" cluster proportion of tobacco use ($p < 0.01$) in the unadjusted models.

Table 5.3: Bivariate and multivariate odds ratios of tobacco use among household heads in rural UP, India (N= 6,218)

Explanatory Variables	Unadjusted Models		Adjusted Model		Adjusted Model with Interaction Terms	
	COR	95% CI	AOR	95% CI	AOR	95% CI
Individual Demography						
Gender (Ref- Men)						
Women	0.07	(0.06, 0.09)	0.07	(0.05, 0.10)	0.18	(0.03, 4.93)
Age up to 30 years [a]	1.10	(1.07, 1.14)	1.08	(1.05, 1.12)	1.09	(1.05, 1.12)
Age above 30 years [a]	0.98	(0.98, 0.99)	0.98	(0.98, 0.99)	0.98	(0.98, 0.99)
Gender (Women) × Age up to 30 years [a b]					0.97	(0.87, 1.08)
Gender (Women) × Age above 30 years [a b]					1.03	(1.01, 1.04)
Marital Status (Ref- Widow/Separated)						
Never married/Not stated	2.26	(1.53, 3.34)	0.95	(0.60, 1.49)	0.92	(0.59, 1.43)
Married	2.45	(2.04, 2.94)	1.07	(0.84, 1.37)	1.08	(0.85, 1.37)
Religion (Ref- Hindu)						
Muslim and others	1.13	(0.94, 1.35)	1.14	(0.91, 1.43)	0.99	(0.80, 1.23)
Gender × Religion (Ref- Women × Hindu) [b]						
Women × Muslim and others					2.85	(1.64, 4.95)
Caste (Ref- General)						
ST/SC	1.37	(1.19, 1.58)	1.06	(0.89, 1.25)	1.12	(0.94, 1.33)
OBC and others	1.36	(1.17, 1.56)	1.05	(0.88, 1.24)	1.08	(0.91, 1.28)
Gender × Caste (Ref- Women × General) [b]						
Women × ST/SC					0.56	(0.33, 0.94)
Women × OBC and others					0.73	(0.43, 1.23)
Education (Ref-Illiterate)						
Up to primary	1.35	(1.19, 1.53)	0.84	(0.72, 0.98)	0.79	(0.67, 0.94)
Secondary	1.19	(1.04, 1.35)	0.60	(0.51, 0.72)	0.55	(0.46, 0.66)
Above secondary	0.57	(0.47, 0.69)	0.31	(0.24, 0.39)	0.29	(0.22, 0.36)
Gender × Education (Ref- Women × Illiterate) [b]						
Women × Up to primary					1.46	(0.85, 2.51)
Women × Secondary					4.15	(2.24, 7.66)
Women × Above secondary					3.48	(1.16, 10.5)
Occupation (Ref- Cultivator)						
Wage laborer	1.04	(0.92, 1.19)	0.93	(0.80, 1.08)	0.92	(0.79, 1.07)
Self-employed & Others	0.95	(0.77, 1.15)	0.97	(0.77, 1.22)	0.99	(0.79, 1.26)
Salaried worker	0.47	(0.35, 0.62)	0.82	(0.59, 1.13)	0.79	(0.58, 1.08)
Housewife	0.07	(0.05, 0.09)	0.70	(0.45, 1.09)	0.68	(0.43, 1.08)
Unemployed	0.47	(0.37, 060)	0.82	(0.62, 1.10)	0.81	(0.61, 1.07)

Explanatory Variables	Unadjusted Models		Adjusted Model		Adjusted Model with Interaction Terms	
	COR	95% CI	AOR	95% CI	AOR	95% CI
Assets quintile (Ref- Quintile 5)						
Quintile 1	1.32	(1.13, 1.55)	1.20	(0.95, 1.51)	1.19	(0.95, 1.51)
Quintile 2	1.45	(1.23, 0.70)	1.12	(0.91, 1.39)	1.11	(0.90, 1.37)
Quintile 3	1.46	(1.24, 1.71)	1.14	(0.94, 1.40)	1.14	(0.93, 1.40)
Quintile 4	1.24	(1.06, 1.44)	1.07	(0.90, 1.28)	1.07	(0.90, 1.28)
Household Size (Ref- Small: up to 5 Member)						
Large (>5 Members)	1.33	(1.19, 1.48)	1.07	(0.94, 1.21)	1.07	(0.94, 1.21)
Individual Psychosocial Factors						
Freedom decision making (Ref- Low)						
High	1.31	(1.10, 1.56)	1.16	(0.95, 1.41)	1.15	(0.94, 1.40)
Perceived Power (Ref-low)						
Medium	1.18	(1.04, 1.34)	1.09	(0.94, 1.25)	1.09	(0.94, 1.25)
High	1.27	(1.02, 1.56)	1.35	(1.07, 1.69)	1.35	(1.08, 1.70)
Material satisfaction (Ref- Low)						
Medium	1.01	(0.87, 1.16)	0.98	(0.83, 1.14)	0.98	(0.83, 1.15)
High	0.87	(0.75, 0.99)	0.91	(0.77, 1.09)	0.91	(0.77, 1.08)
Level of happiness (Ref- Unhappy)						
Neither happy nor unhappy	0.86	(0.75, 1.00)	0.84	(0.71, 1.00)	0.84	(0.71, 1.00)
Happy	0.81	(0.71, 0.91)	0.88	(0.75, 1.03)	0.89	(0.75, 1.04)
Perceived accessibility (Ref- infrastructure worsened)						
Stayed the same	1.34	(1.15, 1.55)	1.51	(1.27, 1.80)	1.60	(1.34, 1.91)
Improved	1.44	(1.22, 1.47)	1.60	(1.32, 1.96)	1.67	(1.36, 2.05)
Gender × Perceived accessibility (Ref- Women × Worsened)						
Women × Stayed the same					0.54	(0.32, 0.89)
Women × Improved					0.58	(0.33, 1.02)
Individual social capital						
Individual organizational Participation	1.04	(0.98, 1.10)	1.06	(1.01, 1.13)	1.07	(1.01, 1.13)
Individual social support	1.03	(0.97, 1.09)				
Individual trust	0.97	(0.92, 1.04)				
Individual social cohesion	0.99	(0.93, 1.05)				
Community social capital						
Community organizational Participation	1.02	(0.96, 1.08)				
Community social support	1.14	(1.08, 1.22)	1.07	(0.99, 1.17)	1.07	(0.98, 1.16)
Community trust	1.04	(0.98, 1.10)				
Community social cohesion	1.1	(1.04, 1.17)	0.98	(0.91, 1.05)	0.99	(0.92, 1.06)

Explanatory Variables	Unadjusted Models		Adjusted Model		Adjusted Model with Interaction Terms	
	COR	95% CI	AOR	95% CI	AOR	95% CI
Community demography						
Gram panchayat size (Ref- Small)						
Medium	0.87	(0.75, 1.02)	0.93	(0.81, 1.06)	0.92	(0.81, 1.05)
Large	0.88	(0.76, 1.02)	1.01	(0.88, 1.16)	1.01	(0.88, 1.16)
Community wealth	0.92	(0.87, 0.98)	0.98	(0.92, 1.05)	0.98	(0.92, 1.05)
PSU health service function improvement	1.17	(0.91, 1.50)	0.96	(0.76, 1.22)	0.97	(0.76, 1.23)
Tobacco consumption in the community						
Social Influence	1.15	(1.10, 1.20)	1.10	(1.05, 1.16)	1.10	(1.05, 1.16)
Observations			6210		6210	

Note: AOR = Adjusted odds ratio, COR = Crude or unadjusted odds ratio, ST/SC = Scheduled castes and scheduled tribes, OBC = Other backward castes
a = Spline terms for age and number of household members, b = Interaction terms with gender

In the adjusted model, among the three social capital factors, only individual *Organizational Participation* was significantly associated with tobacco consumption. After adjusting for confounders, one standard deviation (SD) increase in the standardized factor score of individual *Organizational Participation* was associated with a 6.83% increase in odds of tobacco consumption (Adjusted odds ratio [AOR]= 1.06, 95% CI= 1.01-1.13, p = 0.04). While not significant at p<0.05, higher community *Social Support* was associated with a higher likelihood of tobacco use among household heads (AOR = 1.07, 95% CI: 0.99-1.17; p = 0.08). In the adjusted model, a higher "non-self" cluster proportion of tobacco use had a significantly positive association with tobacco consumption. A 10% increase in "non-self" cluster proportion of tobacco use in the community, was associated with a 10.37% higher odds of tobacco use (AOR = 1.10, 95% CI: 1.05-1.16; p < 0.01).

Apart from the variables of interest, gender presented the strongest association with tobacco use (AOR = 0.07, 95% CI: 0.05-0.10; p < 0.01). As the descriptive analysis indicated (Table 5.2), tobacco consumption pattern appeared to be different across men and women. Thus, we incorporated interaction terms in the adjusted model – first, including interaction terms between gender and all other covariates. Next, we removed the non-significant interaction terms from the model and re-estimated the adjusted model with interaction terms (Table 5.3). The re-estimated model included four significant interaction terms between gender and four covariates – 1) age >30 years, 2) religion, 3) education and 4) perceived accessibility. After including the interaction terms in the model, the direct effect of gender became non-significant. However, the magnitude and direction of *Organizational Participation* and social influence remained consistent.

Among men who were older than 30 years, odds of tobacco use decreased by 2% (AOR = 0.98, 95% CI: 0.97-0.99; p < 0.01) with each year increase in age, whereas for women older than 30 years the odds increased by 3% (AOR =1.03, 95% CI: 1.01-1.04; p = 0.002) with each additional year. Religion did not have a significant association with tobacco use among men. After adjusting for confounders, women household head who were Muslim or from other religion had 2.85 times higher likelihood of using

tobacco product compared to women household head who were Hindu (95% CI: 1.64-4.95; $p < 0.01$). Adjusting for all covariates, higher educational attainment among men was negatively associated, and higher perceived accessibility was positively associated with tobacco use. However, for women household head these associations were reversed.

The adjusted model without the interaction terms presented the best goodness-of-fit to the data with the lowest AIC and BIC values. Both adjusted models presented a non-significant p-value (> 0.05) for the Hosmer-Lemeshow goodness-of-fit test. The estimated adjusted models were robust to models that eliminated outliers (See Appendix 13 for additional goodness of fit and sensitivity analysis)

5.4 Discussion

5.4.1 Discussion of the result

Around two-thirds of household heads within our sample consume any form of tobacco product. After accounting for a large set of covariates, the social influence of tobacco use presented a significant positive association with tobacco consumption. Above and beyond the effect of social influence, participating in community groups and organized social activities had an independent and significant association with one's likelihood of consuming tobacco. Tobacco consumption pattern differs across gender, and it appeared to have a modification effect on key demographic covariates (such as age, religion, education) and perceived accessibility of the household head.

While researchers integrated SCT and social capital theory previously in the context of knowledge sharing and technology acceptance (Chiu, Hsu, & Wang, 2006; Kumar, 2017; Tsai, 2014), this is the first study to integrate these two established theoretical frameworks of social science in the context for a critical NCD risk factor. We conceptualized three pathways to explore the role of social capital and social influence on tobacco use. In our first pathway, we explored whether social influence has a positive association with tobacco consumption and our result supported this notion. Social environment conveys norms and cultural, affecting our behavior during our everyday interaction. The content of the social norm has intrinsic value which can determine how it affects health – either in a positive or negative way. Living in a community where on average two third of other household heads engaged in tobacco consumption may indicate it as normative behavior and may compel individuals to behave in a similar manner to consume tobacco (Mead, Rimal, Ferrence, & Cohen, 2014). While evidence is limited in the Indian context, previous studies substantiated the impact of social influence – also known as the social modeling effect – on tobacco use and substance abuse (Castro et al., 2015; Ennett et al., 2010; Kowalewska & Mazur, 2013; Nagler et al., 2015).

As part of the second pathway, we explored whether constructs of social capital were associated with tobacco consumption indicating its reinforcing effect. Only individual *Organizational Participation* of the household head was associated with tobacco use. The positive association between tobacco use and household head's participation in community groups or social organizations was also confirmed in previous studies. The literature indicates community participation and social interaction might encourage tobacco consumption and smoke (Albert-Lőrincz, Paulik, Szabo, Foley, & Gasparik, 2018; Pförtner et al., 2015). The small magnitude of the association between *Organizational Participation* and tobacco use was also found in other cross-sectional studies in Chile and Sweden (Lindström, Moghaddassi, Bolin, Lindgren, & Merlo, 2003; Sapag et al., 2010). This may be due to constructing social capital measures as a continuous variable. The standardized factor scores of individual *Organizational Participation* ranged from -3.88 to 3.38 (data is not shown). Thus, comparing the household head with the lowest standardized factor score of individual *Organizational Participation,* the household head with highest *Organizational Participation* would have about 36% higher odds of using tobacco products. While not statistically significant, the result showed a positive correlation (AOR: 1.07, 95%CI: 0.99-1.17, p = 0.08) between tobacco consumption and community level social support. Carpiano and Lindström suggested formal or informal social support networks in the community often promotes harmful health-related behavior such as tobacco or alcohol use (Carpiano, 2004; Lindström, 2008).

While our conceptual framework did not explicitly included this concept, the conjunction of individual *Organizational Participation* and social influence may reflect the concept of reciprocal causation. Reciprocal causation is a two-way influence of individual behavior and social environment which explains the behavior of each individual changes the broader social environment, and in turn that social environment affects individual's behavior (Bandura, 2000). A higher level of *Organizational Participation* by an individual who consumes tobacco tend to spread his or her behavior within their social network. And the social influence of tobacco use, in turn, may contribute to how tobacco consumption behavior is developed and sustained by an individual.

Lastly, the result somewhat supported our third pathway – in the adjusted model positive associations was observed between two psychosocial factors (perceived power and accessibility). Perceived power did not present a significant interaction with gender. Intriguingly, when exploring the influence of gender as an effect modifier on the psychosocial factors we observed the positive association of perceived accessibility and tobacco use only among the household heads who were men. Psychosocial factors affect human behaviors by enhancing a person's self-efficacy, confidence, self-control, and self-esteem. Living in a community where tobacco control measures are not active and without any social inhibition, psychosocial factors may enable a person to perform these risk behavior by affecting their self-efficacy (Doubeni, Li, Fouayzi, & DiFranza, 2008; Topa & Moriano, 2010).

This paper has several policy implications. Changing the social norm around tobacco use is our first recommendation. In India, the majority of tobacco control policies focus on individual tobacco control behavior. These include pack warnings, smoke-free zones, sin taxes on tobacco products, behavioral change communication using television/radio campaign and smoking cessation program in a limited capacity (McKay, Patel, & Majeed, 2015). As our result suggested, tobacco consumption in rural UP may have an active social and cultural component. Daily social interaction among caste or social-class based group often accompanied by the use of hookah, bidi or other forms of tobacco (Datta, 2016). By recognizing the nuance of the culture, denormalization of smoked and smokeless tobacco in the community by a community-participatory approach can synergize current tobacco control strategy in India (Kelly, Vuolo, Frizzell, & Hernandez, 2018; Lindström & Giordano, 2016).

While not in India, similar community-based participatory research (CBPR) approach showed improved acceptability of tobacco control measures by changing social norms (Sheikhattari et al., 2016; Steyn, Hoffman, Levitt, Lombard, & Fourie, 2001). Thus, engaging the rural community can play a catalytic role. One approach could be formalizing tobacco control peer-support groups within the existing Village Health Sanitation and Nutrition Committees (VHSNC) including village leaders, ASHAs and health providers (Ministry of Health and Family Welfare, Government of India, 2014). Leveraging

VHSNC will be a cost-effective and culturally acceptable strategy and complement the recently launched Ayushman Bharat program which expanded the scope of community-level primary care by including NCD prevention and treatment (National Informatics Centre (NIC), Ministry of Electronics & Information Technology, Government of India, 2018).

Secondly, the protective effect of education can be leveraged to reorient the traditional anti-tobacco behavioral change communication strategies and adapt them to online and social media platform (Naslund et al., 2017). One such intervention, mCessation – a mobile phone-based anti-smoking text message service – has shown some promising results in recent years (Government of India & Ministry of Health and Family Welfare, 2015). Evaluation and scale-up of such evidence-based interventions are critical to improve health. Incorporation of the information regarding the National Tobacco Quitline and mCessation program in the pack warnings must be effectively implemented for both smoked and smokeless tobacco products at the national and local levels (Cohen et al., 2016).

More research is needed to understand how gender, caste hierarchy and power dynamics in the rural community of India affects both smoked and smokeless tobacco-related norms. Apart from being a part of the communal culture in India, tobacco's contribution towards employment, agriculture, and economy amplify the voice of the farmer lobby and the tobacco industry against effective tobacco control measures (Sharma, Junaid, & Diwakar, 2017). Simultaneously, the tobacco industry leverages government-led infrastructure development to scale up their supply chain, marketing, desirability and accessibility of their product (Berg et al., 2018). To confront the tobacco-related commercial determinants of health (Kickbusch, Allen, & Franz, 2016), a synergistic multisectoral, systemic and participatory approach should be adopted. It is essential to ensure that national, state and local governments enforce the Cigarettes and Other Tobacco Products Act (COTPA).

5.4.2 Limitations of the study

Our result indicated an overall high tobacco consumption among household heads in rural UP. These estimates are higher compared to recent population-level representative GATS (Ministry of Health and Family Welfare, Government of India & Tata Institute of Social Sciences, 2017). Only including the household head as study participants may lead to a higher estimate. Due to the difference in tobacco consumption pattern across gender, ideally, a stratified analysis was required. However, with only 15% of women household heads (n= 906), a stratified analysis would lead to severe sample attrition, and any multiple regression model would not have enough power. Thus, we decided to explore interaction analysis instead. The findings are still generalizable for the broader population as the underlying relationship between tobacco use, social capital, and social influence can be consistent. Moreover, exploring the household head's tobacco consumption is extremely critical as they are the decision maker in the house. Their behavior can impact the health of the household by secondhand smoke (Gonzalez-Barcala et al., 2013; Pattenden et al., 2006) or can provide enabling social cues to other member believing tobacco use is a normative behavior (Mead et al., 2014).

Due to the limitation of data we were unable to account for "*outcome expectations*" which an essential concept of SCT. It is the knowledge of the positive or negative consequence of any behavior which often influences its successful execution (Bandura, 1998). We are assuming that incorporating education as a covariate may have conceptually accounted "*outcome expectations*" (Gilman et al., 2008; Rani et al., 2003). Additionally, some known predictors such as substances abuse, existing comorbidity (e.g., diabetes, hypertension) and psychological stressors (e.g., depression, anxiety) were not included in the analysis due to limited data availability. Self-reported tobacco use is also susceptible to social desirability bias (Persoskie & Nelson, 2013). Lastly, causality or temporal association cannot be established with cross-sectional data. Despite these limitations, having a strong theoretical underpinning is a strength of this study, so is the sufficiently large sample size and accounting for community-level clustering by robust variance estimate.

5.5 Conclusion

The magnitude of tobacco consumption among the household heads in rural UP is very high. Independently both social capital and social influence act as determinants of tobacco use in this context. Recent evidence shows some progress has been made against the tobacco epidemic and momentum exists to continue these actions in this era of sustainable development goals (Ministry of Health and Family Welfare, Government of India & Tata Institute of Social Sciences, 2017). As India is moving through an epidemiological transition (Yadav & Arokiasamy, 2014) any tobacco control policy should address the social context and the intersectoral nature of the tobacco industry and political sustainability. As a solution, our study highlights entry points for action to develop priority setting tools and engage the community in tobacco control strategy using an integrated framework of SCT and social capital theory. We also recommend further exploration of the effect of social participation and gender on tobacco use. A vibrant, democratic country like India probably requires supplementing their current tobacco control efforts with community-level participatory interventions to denormalize the use of smoked and smokeless tobacco.

6. Conclusion

6.1 Summary of the findings

Considering social capital as a critical social determinant of health, this dissertation first challenged the conventional way of measuring the latent constructs of social capital and explored the nuance of the factor structure of social capital across gender using SASCAT-I. Next, uniquely identified constructs of social capital were measured using MCFA, and the relationship of those constructs with communicable disease-related preventive care seeking (DPT3 immunization) and non-communicable disease-related health behavior (tobacco use) were explored. The key findings of the three papers of this dissertation include:

The 13-item SASCAT-I presented uniquely identified a four-factor solution for both men (>18 years) and women (15-49 year) with an adequate model fit. We took a gender binary perspective during the measurement invariance analysis. While the relationship between the associated scale items and two structural social capital factors (*Organizational Participation* and *Social Support*) were invariant across gender, for *Trust* and *Social Cohesion* it was not the same. This implies the interpretation or perception of *Trust* and *Social Cohesion* differed for men and women. Lastly, a three-factor solution (*Organizational Participation*, *Social Support,* and an overall *Cognitive Factor*) was identified as the most parsimonious and best-fitted for women.

As the crosscutting social determinant, community level constructs of social capital had a positive association with immunization of children. Higher collective *Organizational Participation* and *Social Cohesion* among the mothers of the community had statistically significant associations with DPT3 immunization of their child. And, an individual mother's *Organizational Participation* was negatively associated with DPT3 immunization. Due to the cross-sectional nature of the data, we cannot infer causality, and it is possible that when a mother could not vaccinate her child, she became more willing to engage with the community seeking instrumental support. However, this relationship is much more

complicated. Interacting with the contextual factors of the community – such as community wealth – an individual mother's *Organizational Participation* could lead to a higher likelihood of child immunization. This suggests that the beneficial and detrimental effects of social capital may be just the two sides of the same coin.

Individual-level Organizational Participation of the household heads in the formalized group and collective activity was positively associated with tobacco use. Beyond the effect of individual social capital, living in a community with a higher proportion of tobacco user – considered as social influence – was also significantly increased the likelihood of a household head being a tobacco consumer. This could suggest the use of tobacco in everyday life is normative behavior in rural UP. While the association of tobacco use with social capital or social influence did not differ across men and women, gender modified the association of age, religion, education and perceived accessibility with tobacco use. This suggests the pattern of tobacco consumption among household heads may differ across gender and more research is needed to explore these phenomena.

6.2 Contribution to existing research

Despite the extensive breadth and depth of social capital research in the global north and west, studies on social capital in south-east Asia are limited. Our results contribute to the existing literature and knowledge base of social capital's role in health-related behaviors and care seeking practices by focusing on rural northern India.

This dissertation served as a starting point to examine measurement equivalence of social capital across other social stratifies. The first paper to examine the measurement invariance of the latent factor structure of social capital across gender using psychometric analysis. The result concurs with the contemporary social capital theory by identifying social capital as a multidimensional and multilevel construct. We also recommend future psychometric exploration of SASCAT-I among other social stratifiers.

SASCAT-I provides the opportunity to measure social capital within a broader multi-topic household survey in Northern India. This has significant implication in future social capital research as a simplified and validated tool can give social scientist to explore social capital within a multitopic or multi-module survey. While doing that, it is necessary to acknowledge the multidimensionality of social capital and generating summary measure by averaging or summing up item score will produce a biased measure of social capital.

This is the second study in India which used multi-level analysis to explore the contextual effect of social capital on child immunization and the first study which included the social capital measure of mother and household head simultaneously in the analysis. The understanding of the contextual effect of any variable requires a multi-level analytical framework and a large sample size with a multi-staged cluster designed survey. The unique design of the multi-topic survey data used in this analysis gave us an opportunity to explore social capital of rural northern India and presented a snapshot of the social organization and community relationship of this unique caste based communal society.

Using the MCFA model we independently constructed individual and community measure of social capital which was then used to assess the contextual effect of social capital on DPT3 vaccination. Our result provided empirical evidence of the positive externalities of community-level social capital conceptualized by Putnam (1995). Emerged from the collective human relations, a community's *Organizational Participation* and *Social Cohesion* can positively influence the community as a whole. However, the utility of these externalities also depends on the position of an individual in their own social capital. Mothers could utilize their own *Organizational Participation* much more effectively when living in the wealthy community and where VHSNCs were proactive.

This was the first study to link two established theoretical frameworks of social science – SCT and social capital theory. There were only a few instances when SCT and social capital theory were combinedly used in quantitative analysis, and to the best of our knowledge, this is the first application in the context of health. Studies exploring social capital's effect on tobacco use conventionally account for a vast array of demographic, socioeconomic and psychosocial covariates without conceptualizing their confounding relationships. Integration of STC not only allowed this paper to conceptualized and statistically test the reinforcing effect of social capital on tobacco use, but also explore the observational learning by social influence and regulating the effect of self-efficacy by psychosocial factors.

6.3 Future direction and policy implications

The result of the three papers within this dissertation presented the nuance of measurement of social capital. Furthermore, it sheds light on the complexity of social capital's relationship with health-related behaviors, indicating both beneficial effects, as it was initially conceptualized by Bourdieu (1986b) and Putnam (1995), and the detrimental effect proposed by Portes (2014). Acknowledging the cross-sectional nature of the data and not inferring any causal assumption, based on the findings the papers proposed several future research and policy recommendations.

From a methodological perspective, SASCAT-I was able to measure social capital through a short module within a broader multi-topic household survey in rural northern India. However, we recommend further exploration of measurement invariance of the social capital structure across other socioeconomic and cultural groups (such as religion, caste or wealth quintile). Contextualizing the tool for the unique research environment is also necessary for any future application. Findings from chapter three (paper one) also demonstrated social capital has a multi-dimensional property. To have a better understanding of the role of social capital, it is necessary to understand how *Organizational Participation*, *Social Support*, *Trust* and *Social Cohesion* interacted with each other and effect on health both independently and collectively. Thus, we recommend using a factor analytical framework which allows measurement and exploration of correlation of emerging factors simultaneously, rather than generating a score from a simple sum or averaging of scale score.

The differential association between the constructs of social capital and healthcare-seeking behavior was further demonstrated in chapter four (paper two). The findings suggested that child immunization program would benefit from the collective *Organizational Participation* and *Social Cohesion* of the community of mothers. For the community-based EPI and UIP program of India, social participation, collaborative action, and cohesiveness in the community are critical for the continued success of the immunization program. That said, we also found there was a substantial variation of odds of vaccination across the communities. It is necessary to determine if any particular group within the

community is not able to access the benefit of social capital because of their social position. Thus, further exploration of the equity dimension of the immunization program, and social capital is needed before proposing an intervention to build social capital in a community.

Chapter five (paper three) indicated a positive association between individual *Organizational Participation* and the use of tobacco product. This relationship indicates the "social contagion" effect social capital representing the "dark side" of the social capital theory of Alejandro Portes (2014). However, the historical and cultural habit of the community to use tobacco product entrenched in the social norm might be the primary reason. And, participation in formal groups and collective action may be further encouraging this behavior. Therefore, we suggested denormalization of smoked and smokeless tobacco in the community by a participatory approach. VHSNC can play a critical role in this regard. In the past, this committee has been extensively used to improve sanitation, nutrition, and health of the mothers and children. Therefore, leveraging VHSNC to introduce anti-tobacco campaign can be the right step forward.

After all these discussions on social capital, any recommendation to improve social capital as a policy tool is still ambiguous because of its multidimensionality. Where should we propose the change – at the individual level or at the societal? What should we encourage people to do – provide more social support to others or trust each other more? How should we spend our resources – developing social structures to allow social participation or focusing on social engineering to build cohesiveness? There is no one answer to these questions, nor there should be one. However, inequity in the society appears to be the common denominator for unequal distribution of health, welfare, and social capital. Thus, research and policy development needs to use due diligence to account for the social structure, norms, and community relationship during the implementation and scale-up of any intervention. The government must ensure the participation of those who are otherwise socially excluded and enhance the capacity of individuals and communities to bring positive changes in their life.

Appendices

Appendix 1 - Rapid Cognitive interview (RCI)

To improve the validity of the English SASCAT questions, the study implemented a modified version of the cognitive interview. Cognitive interviewing[1] is "the administration of draft survey questions while collecting additional verbal information about the survey responses, which is used to evaluate the quality of the response or to help determine whether the question is generating the information that its author intends." This is a process of asking the participant of the interview to provide additional information about their perception of the question. While performing a full conative interview much more elaborative, the qualitative data collection process is implemented, and the cognitive interview continues until the near situation of the data is achieved (i.e., the respondents understand the questions easily, consistently, and correctly). However, in the context of the broader study and this dissertation research implementing a full-fledged cognitive validation study was not possible due to the resource limitation.

Between the two ways of performing conative interview (thinking aloud vs. verbal probing) we have adopted probing to conduct a shortened version, "rapid cognitive interviewing," to elucidate the understanding of questions by the participant and further improve the wording, phrasing and the categories of SASCAT. The RCI was implemented among the household heads in the local community structured as an informal discussion by moderators experienced in qualitative data collection. A team consisting one moderator and note taker initially approached potential participants to the RCI. They received verbal informed consent, and no personally identifiable data were collected from the participants. After receiving consent, the following steps were performed:

a) Introduction: The moderator explains the objective of the discussion

[1] Beatty, P. C., & Willis, G. B. (2007). Research Synthesis: The Practice of Cognitive Interviewing. Public Opinion Quarterly, 71(2), 287–311. https://doi.org/10.1093/poq/nfm006

b) Question: Fist the initial translated question was asked to the participant

c) Individual comprehension/interpretation: The moderator asked explanations of some specific words from the question

d) Paraphrasing: The moderator asked, "If you were asking this question to your neighbor, how would you say it?"

e) Contextual comprehension/interpretation: The moderator as "Would this question be easy or hard for your neighbor to answer?" (If hard) "Why would it be hard to answer?"

f) The moderator repeats the step b, c, d and e for the next question.

Both moderator and the note taker write down extensive field notes and debrief the study team about the findings. According to the finding of the RCI further modification of the questions are performed. Below one illustrative RCI question is presented:

Rapid cognitive interviewing (RCI) verbal probing steps:

- Ask the respondent:
  Original question: *Do you feel that this village/area is yours?*
  - *Yes*
  - *Sometime*
  - *No*
- Individual comprehension/interpretation:
  - *"Can you explain what these words mean to you: What is the meaning of "feeling something is yours"? Is "village" and "area" means the same thing?"*
- Paraphrasing:
  - *"If you were asking this question to your neighbor, how would you say it?"*
- Contextual comprehension/interpretation:
  - *"Would this question be easy or hard for your neighbor to answer?" (If hard) "Why would it be hard to answer?"*
- After performing the RCI and performing adequate changes in the question we finalized this question as:
  - *"Do you feel that you have a sense of belonging to this village?"*

Appendix 2 - SASCAT, SASCAT-B and modified SASCAT-India (SASCAT-I)

	SASCAT	SASCAT-B	SASCAT-I
Structural Social Capital	***Group Membership***		
	1. In the last 12 months have you been an active member of any of the following types of groups in your community? • Work related/trade union • Community association/co-op • Women's group • Political group • Religious group • Credit/funeral group • Sports group • Other: specify	1a. In the last 12 months, have you been a member of the following types of groups in your area? • Vocational training group • Savings group/community cooperative • Political group • Religious group • Microcredit program • Sports club • Youth/student club • Other: specify	1a. In the last 12 months have you been a member of any of the following groups? • Group from where you can get loans (Microcredit group) • Group from which you can receive any training • Self-help Groups (SHG) • Any other women group • Farmer/ Fisherman/ Cattle herder's group • Businessman/ Professionals group • Religious group • Gram panchayat and its committee • Village Council • Village health, sanitation, and nutrition committee • School management committee • Youth/student group or club • Political group • Other: specify
		1b. In the last 12 months, how would you describe your involvement in the groups in which you are a member? • Received a loan or other form of financial support • Attended meetings • Attended training • Participated in decision making • Served as a leader of the group • Other: specify	1b. In the last 12 months, how have you participated in or benefited from the group? • Received a loan or other form of financial support • Received any in-kind support (other than financial) • Provide Financial contribution to the group • Attended meetings • Attended training • Participated in decision making • Served as a leader of the group • Other: specify
	Social Support		
	2. In the last 12 months, did you receive from the group any emotional help, economic help or assistance in helping you know or do things?	2a. Suppose you had something unfortunate happen to you, such as a father's sudden death. Who would help you in this situation? • Immediate family • Relatives • Neighbors	2. In the last 12 months, did you receive any emotional support any sudden or unfortunate event (like a death of a family member or other troubling event) from any of the following people? • Immediate family • Relatives • Neighbors

	• Work related/trade union • Community association/co-op • Women's group • Political group • Religious group • Credit/funeral group • Sports group • Other: specify	• Friends who are not neighbors • Community leaders • Religious leaders • Politicians • Government officials/civil service • Person from NGO • A group in which I am a member • A group in which I am not a member • Other: specify	• Friends (not -neighbor) • Co-workers • Healthcare provider • Leaders of the Village • Religious leaders • Political Leaders • Government officials • Personnel from NGO • Other: specify
	SASCAT	**SASCAT-B**	**SASCAT-I**
Structural Social Capital	3. In the last 12 months, have you received any help or support from any of the following, this can be emotional help, economic help or assistance in helping you know or do things? • Family • Neighbors • Friends who are not neighbors • Community leaders • Religious leaders • Politicians • Government officials/civil service • Charitable organizations/NGO • Other: specify	2b. Suppose you suffered an economic loss, such as job loss (urban)/crop failure (rural). In that situation, who do you think would assist you financially[a]? 2c. Suppose you are (female)/your wife is (male) preparing to give birth to your (female)/her (male) first child. Who do you think would provide you (female)/her (male) advice or assistance in this situation[a]?	3. In the last 12 months, did you receive any financial support for any economic loss (such as crop failure, loss of livestock, loss of a job, or something similar) loss from any of the following people? This may include receiving or borrowing money[b]. 4. In the last 12 months, did you receive any support, advice or assistance from any of the following people for seeking healthcare (Such as taking a family member or friend to the doctor or hospital)[b] ?
	Collective Action		
	4. In the last 12 months, have you joined together with other community members to address a problem or common issue? • Yes • No 5. In the last 12 months, have you talked to a local authority or governmental organization about problems in this community? • Yes • No	3. In the last 12 months, have you joined together with others in your area to address important issues? • Yes • No 4. In the last 12 months, have you talked with a local leader, chairman, or governmental organization about the development of your area? • Yes • No	5. In the last 12 months, have you worked together with other community members and attempted to address a problem or common issue of the village? • Yes • No 6. In the past 12 months, have you spoken with anyone about the development of your village? • Leaders of the Village • Religious leaders • Political Leaders • Government officials • Personnel from NGO

			• Others: specify
Cognitive Social Capital	***Trust*** 6. In general, can the majority of people in this community be trusted? • Yes • No	5a. Can your neighbors be trusted? • Yes • Sometimes • No 5b. Can leaders in this area be trusted? • Yes • Sometimes • No	7. Overall, do you think the leaders of your village can be trusted? • Yes • Sometimes • No 8. Overall, do you think your neighbors in your village can be trusted? • Yes • Sometimes • No 9. Overall, do you think people you are not familiar residing in your village can be trusted? • Yes • Sometimes • No

	SASCAT	**SASCAT-B**	**SASCAT-I**
Cognitive Social Capital	***Social Cohesion*** 7. Do you think that the majority of people in this community would try to take advantage of you if they got the chance? • Yes • No 8. Do the majority of people in this community generally get along with each other? • Yes • No	6. Do you think that the majority of people in this area would try to take advantage of you if they got the chance? • Yes • Sometimes • No 7. Do the majority of people in this area generally have good relationships with each other? • Yes • Sometimes • No	10. Do you think that the majority of people in your village would try to take advantage of you if they got the chance? • Yes • Sometimes • No 11. Do you think the majority of people in this village generally have good relationships with each other? • Yes • Sometimes • No

9. Do you feel as though you are really a part of this community? • Yes • No	8. Do you feel that this area is yours? • Yes • Sometimes • No	12. Do you feel that you have a sense of belonging to this village? • Yes • Sometimes • No

Note: [a]Use the same list of response options as in Question 2a.
[b]Use the same list of response options as in Question 2.

Appendix 3 - Polychoric correlation of 12 social capital items generated from SASCAT-I

	Items	Organizational Participation			Social Support			Trust			Social Cohesion		
		GM	CA	DD	ES	FS	IS	TL	TN	TS	SCR	SCSB	SCF
	Polychoric correlation of the total sample (n= 12,473)												
Structural Component	GM	**1**											
	CA	0.22	**1**										
	DD	0.23	0.62	**1**									
	ES	0.08	0.11	0.13	**1**								
	FS	0.07	0.10	0.16	0.21	**1**							
	IS	0.09	0.07	0.12	0.26	0.21	**1**						
Cognitive Component	TL	0.08	0.21	0.16	0.03	0.00	-0.02	**1**					
	TN	0.05	0.09	0.09	-0.01	0.00	-0.01	0.49	**1**				
	TS	0.05	0.27	0.16	0.00	0.01	-0.06	0.40	0.33	**1**			
	SH	0.08	0.16	0.09	-0.01	0.01	-0.01	0.33	0.45	0.20	**1**		
	SB	0.04	0.02	0.07	-0.04	0.12	0.12	0.27	0.44	0.16	0.51	**1**	
	SF	0.05	0.16	0.07	0.06	0.04	0.11	0.14	0.18	0.14	0.24	0.29	**1**
	Polychoric correlation of the sample of women in the upper triangle (n= 7,186)												
Structural Component	GM	**1**	0.21	0.20	0.08	0.06	0.09	0.12	0.07	0.05	0.10	0.08	0.05
	CA	0.26	**1**	0.56	0.08	0.15	0.06	0.16	0.13	0.23	0.18	0.06	0.08
	DD	0.30	0.61	**1**	0.16	0.09	0.13	0.15	0.08	0.14	0.05	0.03	0.01
	ES	0.08	0.16	0.13	**1**	0.18	0.24	0.04	0.01	0.02	0.01	-0.03	0.03
	FS	0.08	0.06	0.20	0.27	**1**	0.18	0.03	-0.05	0.02	0.04	0.08	0.00
	IS	0.09	0.14	0.18	0.29	0.26	**1**	-0.04	-0.03	-0.10	0.02	0.15	0.09
Cognitive Component	TL	0.03	0.20	0.13	0.04	-0.04	0.02	**1**	0.50	0.31	0.29	0.27	0.10
	TN	0.03	0.02	0.04	-0.03	0.06	0.06	0.47	**1**	0.35	0.44	0.42	0.13
	TS	0.06	0.26	0.12	-0.02	0.00	0.03	0.48	0.27	**1**	0.20	0.14	0.07
	SH	0.06	0.10	0.07	-0.03	-0.03	-0.03	0.36	0.45	0.16	**1**	0.46	0.23
	SB	-0.01	-0.07	0.04	-0.03	0.18	0.11	0.23	0.44	0.15	0.56	**1**	0.24
	SF	0.05	0.16	0.09	0.15	0.08	0.18	0.19	0.23	0.20	0.23	0.37	**1**
	Polychoric correlation of the sample of men in the lower triangle (n= 5,287)												

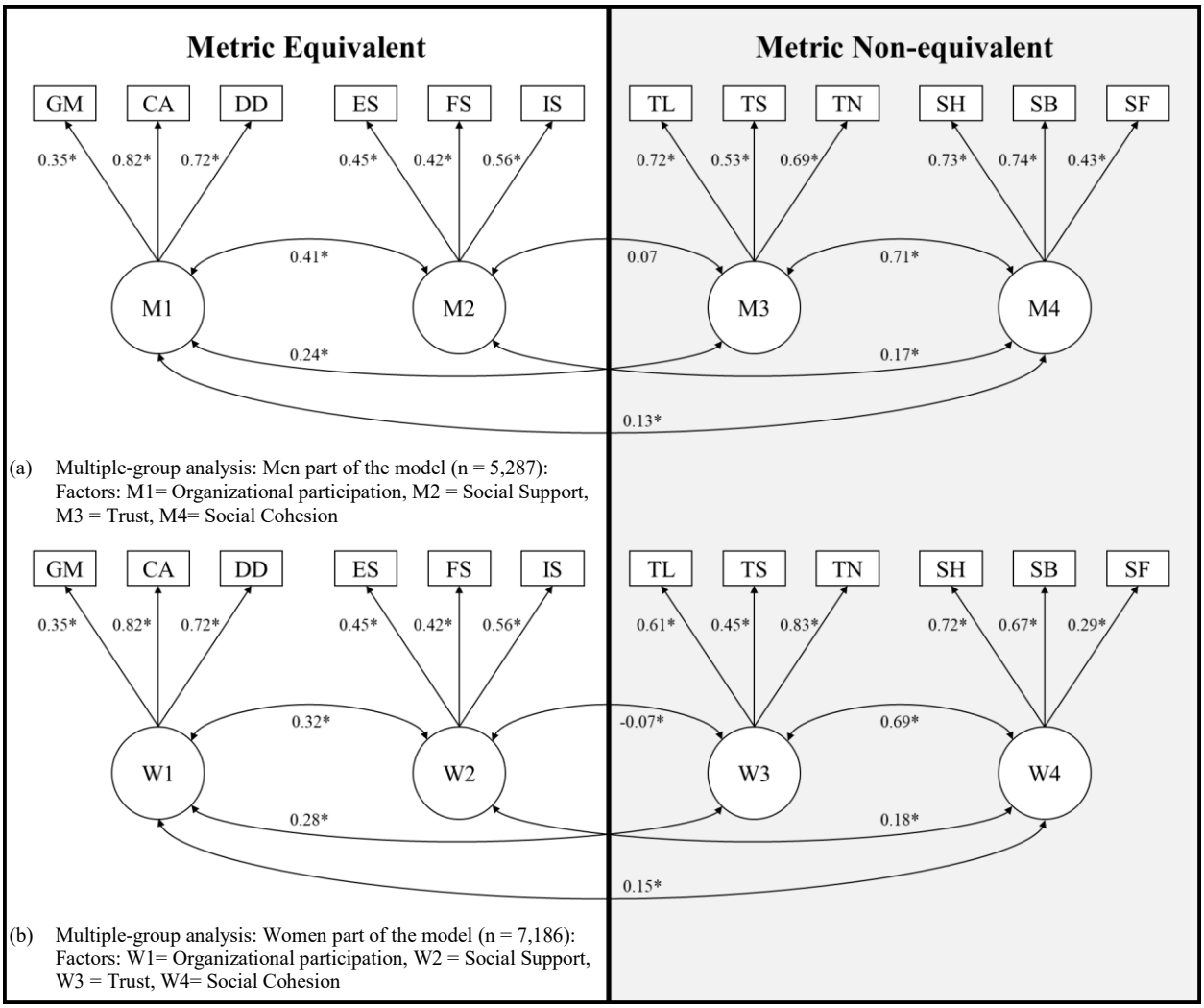
Note: GM = Group Membership, CA = Collective Action, DD = Development Discussion, ES = Emotional Support, FS = Financial Support, IS = Informational Support, TS = Trust in Leaders, TS = Trust in Strangers, TS = Trust in Neighbors, SH = Social Harmony, SB = Sense of Belonging, SF = Sense of Fairness

Correlation between items from the same constructs

Correlation between items from the same social capital constructs but within the same components of social capital

Correlation between items from the different social capital constructs with different social capital component

Appendix 4 - Path diagrams of the multiple group analysis across gender with partial metric invariance with standardized factor loadings and inter-factor correlations for men (a) and women (b)



Note: * = P <0.05
GM = Group Membership, CA = Collective Action, DD = Development Discussion,
ES = Emotional Support, FS = Financial Support, IS = Informational Support, TS = Trust in Leaders,
TS = Trust in Strangers, TS = Trust in Neighbors, SH = Social Harmony, SB = Sense of Belonging,
SF = Sense of Fairness

Appendix 5 - Description of the explanatory variables used in chapter four (paper two)

Variables	Description	Type
Social Capital: the cross-cutting determinant		
Individual Social Capital for Household Head and Mothers		
Individual organizational participation	Individual standardized factor score derived from level 1 of Multilevel MCFA	Continuous
Individual social support	Individual standardized factor score derived from level 1 of Multilevel MCFA	Continuous
Individual trust	Individual standardized factor score derived from level 1 of Multilevel MCFA	Continuous
Individual social cohesion	Individual standardized factor score derived from level 1 of Multilevel MCFA	Continuous
Community Level Social Capital for Household Head and Mothers		
Community organizational participation	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Community social support	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Community trust	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Community social cohesion	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Structural Determinants		
Individual Structural Determinants: Socioeconomic Position		
Gender of the child	Self-reported age of the child by the mother	Two Categories - Male - Female
Household Level Structural Determinants: Socioeconomic Position		
Marital status of the household head	Self-reported marital status of the household head	Two Categories - Married Single or Widowed/Divorced/Separated
Education of the household head	Self-reported educational attainment of the household head	Three Categories - Illiterate - Up to primary (5^{th} grade) - Above primary
Occupation of the household head	Self-reported occupation of the household head	Four Categories - Cultivator - Wage laborer - Salaried worker - Unemployed/Student/Housewife
Education of the mother	Self-reported educational attainment of the mother	Three Categories - Illiterate - Up to primary (5^{th} grade)

Variables	Description	Type
		- Above primary
Occupation of the mother	Self-reported occupation of the mother	Four Categories - Employed - Unemployed
Household size	Self-reported number of a household member living in the house for the last six months by the household head	Continuous
Religion	Self-reported religion of the household	Two Categories - Hindu - Muslim and others
Caste	Self-reported social caste of the household	Three Categories - General - ST/SC - OBC and others
Socioeconomic status (assets quintile)	Asset index developed by principal component analysis using 27 binary variables. The variables include information regarding ownership of household assets, house and land ownership. The standardized score of the first component was used to create five asset quintile group.	Five Categories: Quintile 1 to 5
Community Structural Determinants: Socioeconomic Position		
Community wealth	Average scores of the first component of principal component analysis from the households of each cluster. The score is standardized for more natural interpretation	Continuous
Community average education of the mothers	The average level of education of the mothers in the community derived from aggregating self-reported educational attainment of the mother from each PSU as a contextual variable	Continuous
Proportion of scheduled caste population in the community	The proportion of scheduled caste is considered as a proxy of caste diversity in a community. This variable is extracted from the National census of India 2011	Continuous
Community Structural Determinants: Socioeconomic and Political Context		
Census Blocks	Smallest geographical region linked with administrative boundary of the government which also serves as the enumeration block of the Census in each district	Six Categories: Behadar Kachhauna Kothwan Kasmanda Machhrehta Sidhauli
Presence of active Village Health, Sanitation and Nutrition committee (VHSNC)	Presence of a Village Health, Sanitation and Nutrition committee which is currently active according to at least 33% of the household heads in a PSU	Binary - Yes - No
Improvement of the Community Health Service	Average cluster score of an individual's perceptions on the improvement of community health services within the last 12 months	Continuous

Variables	Description	Type
	Intermediary Determinants	
Individual Intermediary Determinants: Material Circumstances, Psychosocial, Behaviors and Biological Factors		
Age of the child	Self-reported age of the child by the mother	Four Categories: - 12-23 month - 24-35 months - 36-47 months - 48-59 months
Child's birth order	Self-reported berth order of the child by mother	Two Categories: - First Born - Not first born
Household Level Intermediary Determinants: Material Circumstances, Psychosocial, Behaviors and Biological Factors		
Age of the household head	Self-reported age of the household head in years	Continuous
Number of immunization information source of the household head	Self-reported number of the information sources from where he/she received any information related to a child's immunization	Continuous (1 to 9)
Age of the mothers	Self-reported age of the mothers in years	Continuous with two spline terms: - Age 15-21 year - Age 22-49 year
Number of immunization information source of the mother	Self-reported number of the information sources from where she received any information related to a child's immunization	Continuous (1 to 9)
Freedom of making decisions of the mothers	Derived from the question: "How much freedom do you have in making personal decisions?"	Five Categories - No freedom at all - Freedom in very few decisions - Freedom in some decisions - Freedom in most decisions - Freedom in all decisions
Household Financial Stability	Derived from the question: "In the last 12 months, how has your financial situation changed overall?". Two separate categories were developed from the original responses: 1. Worsen = "You are forced to go into debt" or "After spending all of your regular income, you had to draw from your savings" 2. Stable or Improved = "You were just able to meet your expenses (no savings, no debt)" or "You were able to put some money aside (savings)" or "You were able to put quite a bit of money aside (savings)"	Two Categories - Worsen - Stable or Improved

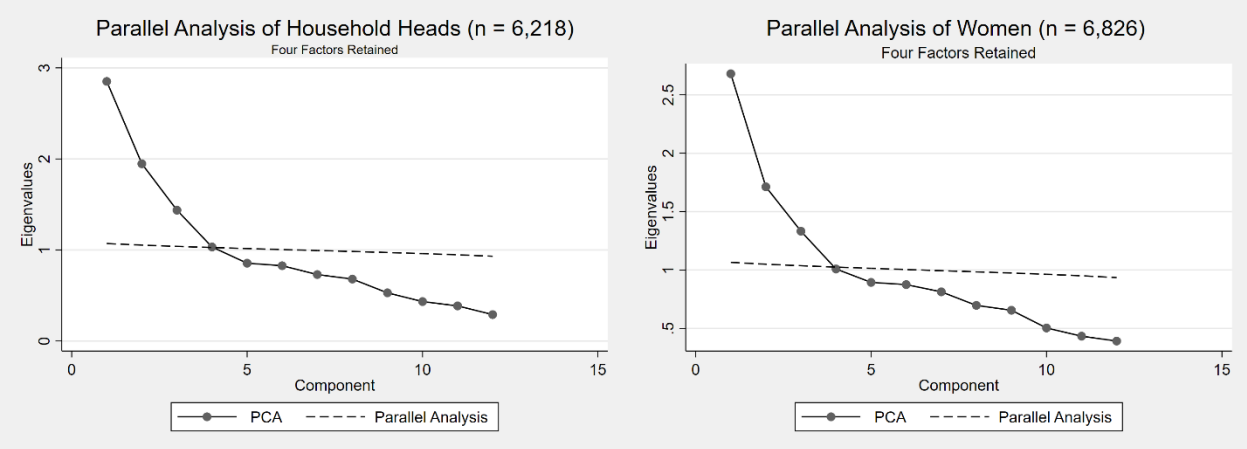
Variables	Description	Type
Community Level Intermediary Determinants: Material Circumstances, Psychosocial, Behaviors And Biological Factors		
Community average of child age	The average age of the 12-59 month children in the community derived from aggregating the age of the individual child from each PSU as a contextual variable	Continuous
Community average information source number	Average of information sources of immunization derived from aggregating the cumulative number of the information sources of immunization reported by both household head and mothers from each PSU as a contextual variable as a contextual variable	Continuous
Individual Intermediary Determinants: Health Systems related factors		
Immunization place	Type of the facility from where the children received most of the immunizations reported by the mother	Three Categories - AWC or VHND - Sub-Centers - PHC, CHC or Hospital
Mothers regular communication with FLWs	Mother's interaction with either ASHA, AWW or ANM within the last six months	Binary - Yes - No
Mother's knowledge about incurring VHNDs	Mother knew about the incurring VHND in the community	Binary - Yes - No

Note: AWC = Anganwadi Center, CHC = Community Healthcare Center, MCFA= Multilevel confirmatory factor analysis, OBC = Other backward castes, PHC = Primary Healthcare Center, ST/SC = Scheduled castes and scheduled tribes, VHND = Village Health and Nutrition Day,

Appendix 6 – Multilevel confirmatory factor analysis to generate social capital measures for household heads and mothers of the child used in chapter four (paper two)

Adapted from original SASCAT (De Silva et al., 2006) and SASCAT-B (Story et al., 2015b) using rapid cognitive interviewing, the modified-SASCAT is a self-reported measure of social. The study sample household heads (≥18years and n = 6,218) and all women between 15-49 year of age (n = 6,826) responded to the modified-SASCAT during a community-level multistage cross-sectional survey. To assess the factor structure of social capital, 12 binary items were generated from 13 self-reported questions of modified SASCAT. The first seven questions of the tool are related to structural social capital - Group membership (2 questions), Collective action (2 questions), Social support (3 questions). The last six questions are related to cognitive social capital- Trust (3 questions) and Social Cohesion (3 questions). Four unique factors were identified for both household head and women in the household during Horn's (1965) parallel analysis.

Figure: Scree plots indicating the possible number of factors identified at the individual level for household heads and women using SASCAT-I



Note: Figures illustrates the expected eigenvalues (the solid line) and parallel analysis (the dotted line). PCA = Principal Components Analysis

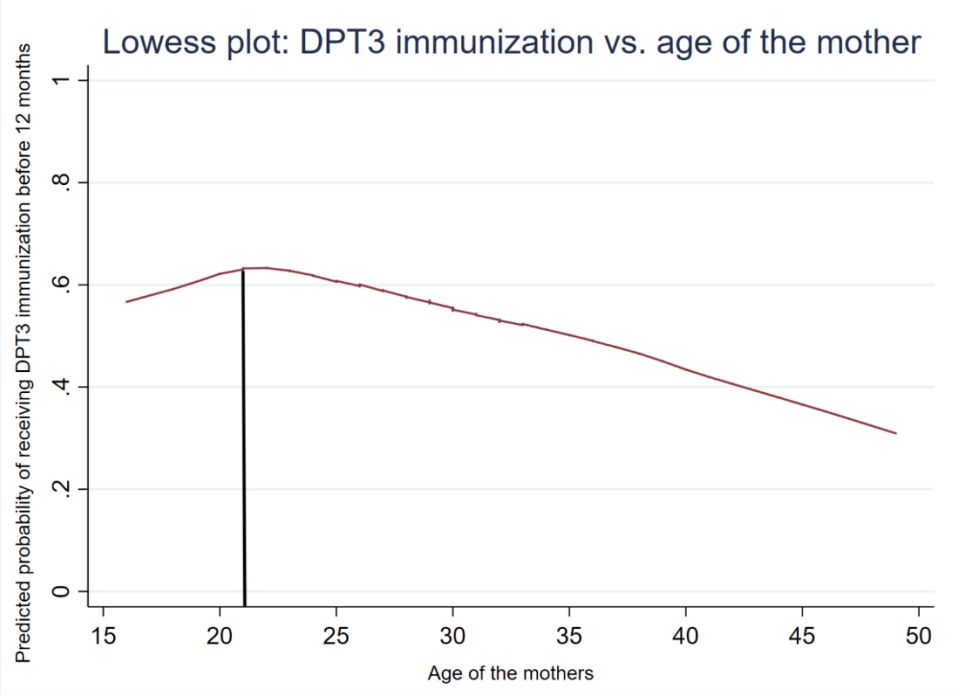
Next, independently the factor structure of household head and women were identified through multi-level exploratory factor analysis (MEFA) using “Weighted Least Square Mean and Variance” (WLSMV) adjusted estimator using polychoric correlation matrix and holding factor variances fixed to one. We considered the four-factor solution both individual and community level. Both MEFA model presented adequate fit with the data (Household Head MEFA: RMSEA= 0.021, CFI = 0.983, TLI = 0.952, SRMR within = 0.04 and SRMR between = 0.04, $\chi 2$ value= 176.371, df= 48, $p<0.01$; Women MEFA: RMSEA= 0.009, CFI = 0.996, TLI = 0.988, SRMR within = 0.023and SRMR between = 0.059, $\chi 2$ value= 74.433, df= 48, $p<0.01$). Next, to assess the construct validity of the social capital factor structure and to generate standardized factor score of each construct of social capital we conducted a multilevel confirmatory factor analysis (MCFA) which resulted "Maximum Likelihood Robust" estimator using polychoric correlation matrix and holding factor variances fixed to one. Associated standardized factor scores of the eight social capital constructs of the household head (four at individual and four at community level) and eight social capital constructs of the women were extracted from the MCFA model.

Table: Pearson correlation between standardized social capital factor score generated by Multilevel confirmatory factor analysis of household heads (n = 1,749) and mothers (n = 1,779)

			Mother of 12-59 Month Child								Household Head							
			Individual				Community				Individual				Community			
			OP	SS	TR	SC	OP	SS	TR	SC	OP	SS	TR	SC	OP	SS	TR	SC
Mother of 12-59 Month Child	Individual	OP	**1**															
		SS	-0.98	**1**														
		TR	0.20	-0.11	**1**													
		SC	0.35	-0.21	0.84	**1**												
	Community	OP	0.12	-0.11	-0.04	0.05	**1**											
		SS	-0.40	0.41	-0.01	0.01	-0.37	**1**										
		TR	0.16	-0.16	-0.31	-0.05	0.23	0.32	**1**									
		SC	0.01	0.02	0.20	0.14	-0.70	0.43	-0.01	**1**								
Household Head	Individual	OP	-0.01	0.01	0.02	0.01	0.02	0.01	-0.05	0.00	**1**							
		SS	-0.02	0.02	0.03	0.01	0.01	0.00	-0.05	0.01	0.98	**1**						
		TR	-0.02	0.03	0.02	0.06	0.01	0.01	-0.03	0.00	0.39	0.32	**1**					
		SC	-0.01	0.02	0.02	0.05	0.01	0.03	-0.01	0.00	0.49	0.37	0.89	**1**				
	Community	OP	-0.02	0.01	-0.04	-0.06	-0.01	-0.01	0.05	0.00	-0.24	-0.18	-0.33	-0.38	**1**			
		SS	-0.05	0.04	-0.03	-0.04	0.00	0.06	0.09	0.03	-0.30	-0.25	-0.30	-0.32	0.43	**1**		
		TR	0.00	0.01	0.06	0.05	-0.02	0.01	-0.05	0.10	0.22	0.24	0.30	0.16	0.09	-0.04	**1**	
		SC	-0.08	0.08	-0.04	-0.05	-0.01	0.04	0.03	-0.03	0.06	0.11	-0.16	-0.17	0.46	0.61	-0.07	**1**

Note: OP = Organizational participation, SS = Social Support, TR = Trust, SC= Social Cohesion

Appendix 7 – Locally weighted scatterplot smoothing (Lowess) plots for DPT3 immunization vs. the age of the mother used in chapter four (paper two)



Appendix 8 – Regression diagnostics of models used in chapter four (paper two)

In this study, we have developed six mixed-effect multilevel logistic regression models to explore the adjusted association of social capital and DPT3 immunization status. The models are as follows:

- **Model 1:** An unconditional baseline mean model without any covariates
- **Model 2:** Model adjusted for household head's individual standardized factor scores of social capital of household head and mothers
- **Model 3:** Model 2 + community-level social capital standardized factor scores of social capital of household head and mothers
- **Model 4:** Model 3 + covariates related to the child, mother and household head
- **Model 5:** Model 4 + Household characteristics
- **Model 6:** Model 5 + Community characteristics and contextual variables

To perform the regression diagnostics and goodness of fit we have performed a wide range of regression diagnostics. Description and result of those tests are presented below.

A. AIC (Akaike information criterion) and log-likelihood:

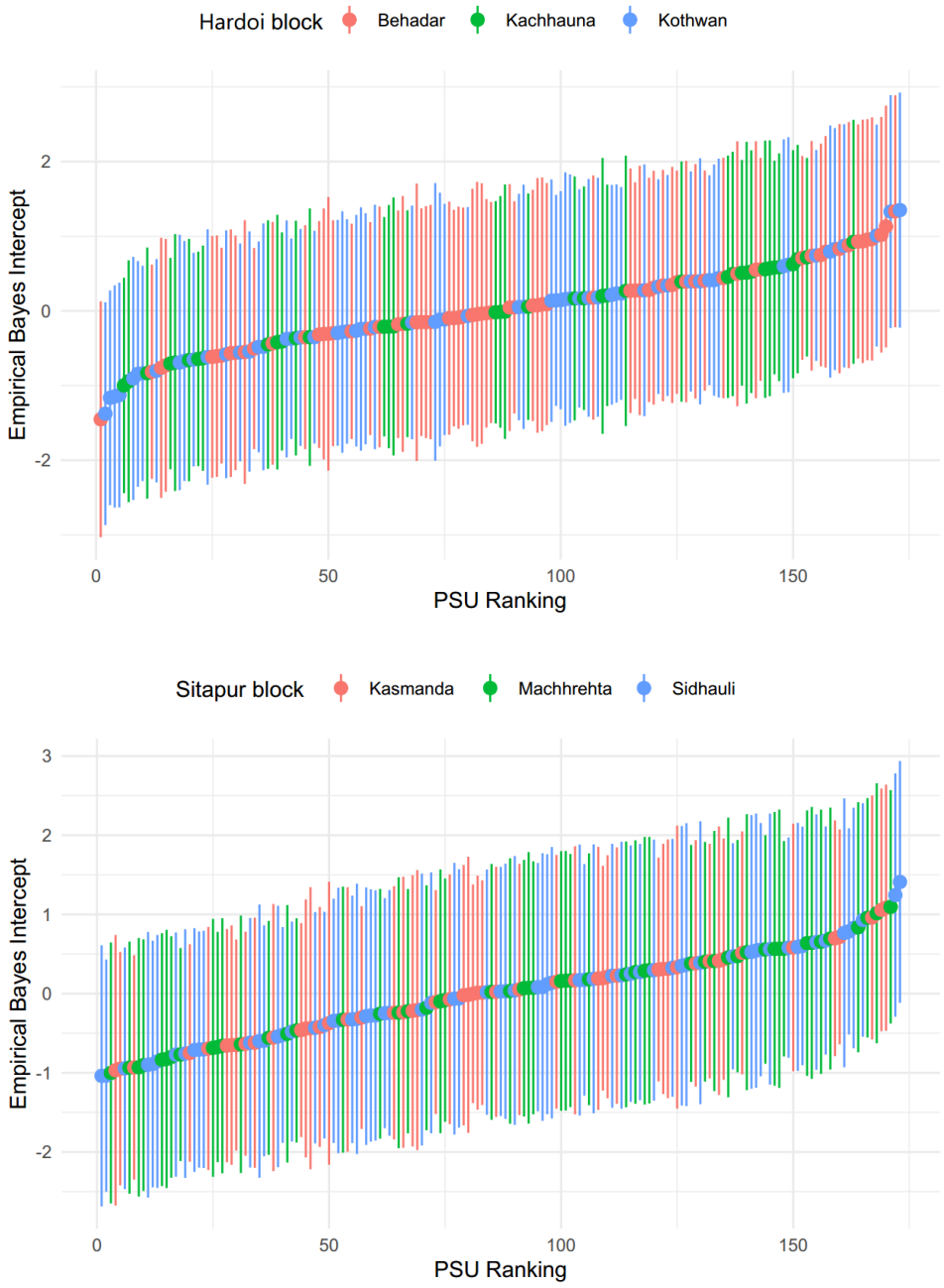
Based on the AIC and BIC Model 6 presented the best goodness of fit:

Models	AIC	Log Likelihood
Model 1	2928.0	-1460.9
Model 2	2918.6	-1450.3
Model 3	2914.7	-1440.4
Model 4	2680.6	-1307.3
Model 5	2682.8	-1303.4
Model 6	2668.1	-1291.0

B. Estimated residual ICC and variance from the multilevel mixed-effect logistic model

	Residual ICC		Change of ICC (%)		Residual variance		Change of variance (%)	
	Household	Community	Household	Community	Household	Community	Household	Community
Model 1	54.11%	17.49%			2.63	1.25		
Model 2	52.31%	17.31%	3.33	1.08	2.41	1.19	8.01	4.82
Model 3	51.24%	15.96%	2.06	7.75	2.38	1.08	1.47	9.79
Model 4	55.21%	15.98%	-7.76	-0.09	2.88	1.17	-21.12	-8.98
Model 5	54.40%	16.69%	1.47	-4.45	2.72	1.20	5.59	-2.59
Model 6	53.56%	13.59%	1.55	18.60	2.83	0.96	-4.06	20.08
Average	53.47%	16.17%						

C. Distribution of the PSU level random intercept with a 95% confidence interval across Hardoi and Sitapur districts color-coded by census blocks in Uttar Pradesh

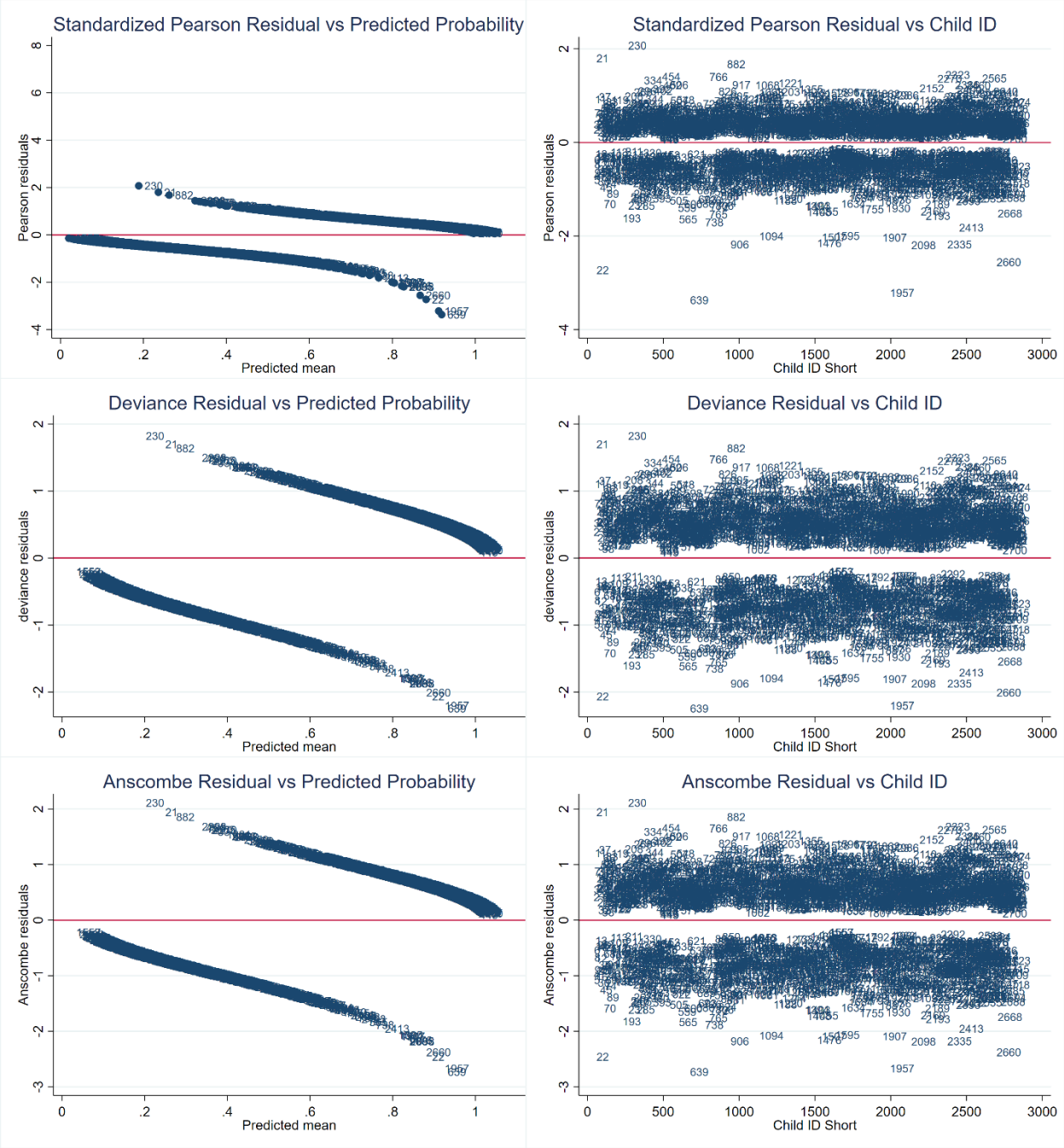


D. Variation inflation factor (VIF):

The covariate pattern of the Model 6 presented VIF < 10

Variable	VIF	1/VIF
Individual Mother's Organizational Participation	1.82	0.550467
Individual Mother's Trust	5.06	0.197457
Individual Mother's Social Cohesion	4.69	0.213415
Individual Household Head's Organizational Participation	1.77	0.565350
Individual Household Head's Trust	5.98	0.167128
Individual Household Head's Social Cohesion	6.36	0.157326
Community Level Mother's Organizational Participation	2.71	0.368387
Community Level Mother's Social Support	2.35	0.425640
Community Level Mother's Trust	2.24	0.446449
Community Level Mother's Social Cohesion	2.59	0.385627
Community Level Household Head's Organizational Participation	1.64	0.611371
Community Level Household Head's Social Support	2.13	0.468924
Community Level Household Head's Trust	1.43	0.699271
Community Level Household Head's Social Cohesion	2.23	0.449288
Age of the Children		
12 to 23 Months	1.74	0.575658
24 to 35 Months	1.65	0.605863
36 to 47 Months	1.66	0.601116
Mothers Age upto 21	1.10	0.908069
Mothers Age above 21	1.28	0.782214
Mothers Education		
Up to Primary	1.26	0.793399
Above Primary	1.59	0.628024
Mothers Number of immunization information Source	1.36	0.735294
Mothers Regular Communication with FLWs	1.13	0.885605
Mothers Knowledge about Incurring VHNDs	1.13	0.881318
Mothers Freedom of Decision Making		
Freedom in very few decisions	1.87	0.535889
Freedom in some decisions	2.00	0.499926
Freedom in most decisions	1.78	0.561241
Freedom in all decisions	1.72	0.582320
Household Head's Marital Status	1.03	0.967290
Household Head's Number of immunization information Source	1.45	0.688167
Total Number of Household Members	1.10	0.908121
Household Wealth		
Quintile 2	1.80	0.557012
Quintile 3	2.00	0.499455
Quintile 5	2.12	0.472071
Quintile 2	2.24	0.446024
Community Wealth	1.25	0.801266
Community average age of children	1.13	0.883772
Community average mothers' education	1.55	0.644701
Community average Number of immunization information source	1.77	0.564785
Presence of active VHSNC in the community	1.16	0.860457
Mean VIF	2.07	

E. Examining residual and predicted values



The following observations presented high influence:

21, 22, 230, 595, 639, 882, 906, 1094, 1476, 1507, 1907, 1957, 2098, 2335, 2413, 2660

F. Sensitivity analysis by removing observations with high influence from the regression sample:

The following table presents the result of the sensitivity analysis of the final regression model (Model 6)

Explanatory Variables	(1) Model 6	(2) Model 6 removing high influence observation
Individual Social Capital		
Mother's Organizational Participation	0.82*	0.79
Mother's Trust	1.05	0.97
Mother's Social Cohesion	1.10	1.24
Household Heads's Organizational Participation	1.07	1.11
Household Heads's Trust	1.02	0.98
Household Heads's Social Cohesion	0.87	0.84
Community Social Capital		
Mother's Organizational Participation	1.47*	1.69**
Mother's Social Support	0.78	0.74
Mother's Trust	0.86	0.76
Mother's Social Cohesion	1.72***	2.01***
Household Heads's Organizational Participation	1.00	0.99
Household Heads's Social Support	0.96	0.98
Household Heads's Trust	0.86	0.84
Household Heads's Social Cohesion	1.04	1.00
N	2,161	2,145

Sensitivity analysis by including interaction terms with the three-level mixed-effect models 6 (M6) for fixed-effect estimates for DPT3 immunization

Fixed effects	IM1	IM2	IM3	IM4
Individual Social Capital	**AOR**	**AOR**	**AOR**	**AOR**
Mother's Organizational Participation	0.82*	0.81*	0.82	0.69**
Mother's Trust	1.05	1.05	1.07	1.06
Mother's Social Cohesion	1.10	1.09	1.07	1.06
Household Head's Organizational Participation	1.07	1.07	1.07	1.07
Household Head's Trust	1.02	1.01	1.01	1.01
Household Head's Social Cohesion	0.87	0.88	0.88	0.87
Community Social Capital				
Mother's Organizational Participation	1.47*	1.47*	1.49**	1.50*
Mother's Social Support	0.78	0.79	0.78	0.78
Mother's Trust	0.86	0.87	0.86	0.86
Mother's Social Cohesion	1.72***	2.54***	1.72***	1.72***
Household Head's Organizational Participation	1.00	0.99	1.02	1.00
Household Head's Social Support	0.96	0.95	0.97	0.94
Household Head's Trust	0.86	0.86	0.86	0.86
Household Head's Social Cohesion	1.04	1.03	1.04	1.05
Child's characteristics				
Age categories (Ref- 48 to 59 months)				
12 to 23 months	4.46***	4.56***	4.45***	4.47***
24 to 35 months	3.64***	3.78***	3.61***	3.69***
36 to 47 months	1.96**	2.00***	1.97**	1.96**
Birth Order (Ref- Firstborn)				
Not first born (second/third/fourth)	1.06	1.04	1.07	1.06
Mother's characteristics				
Age 15-21 (Year)	1.26	1.27	1.25	1.24
Age 22-49 (Year)	0.96**	0.96**	0.96*	0.96**
Education (Ref-Illiterate)				
Up to Primary	1.63*	1.64*	1.63*	1.67*
Above Primary	2.52***	2.55***	2.45***	2.56***
Number of immunization information source	1.40***	1.29**	1.40***	1.40***
Regular Communication with FLWs (Ref- No)				
Yes	1.40*	1.45*	1.41*	1.39
Knew about incurring VHNDs (Ref- No)				
Yes	1.28	1.24	1.27	1.26
Freedom of Decision making (Ref- No freedom at all)				
Freedom in very few decisions	1.33	1.35	1.37	1.32
Freedom in some decisions	1.46	1.43	1.52	1.49
Freedom in most decisions	0.96	0.95	0.99	0.96
Freedom in all decisions	0.91	0.86	0.96	0.92
Household Head's characteristics		1.35	1.37	1.32
Marital Status (Ref- Single/ Widowed/Divorced)				
Married	1.64*	1.68*	1.62*	1.60
Number of immunization information source	1.01	1.01	1.02	1.01
Household's characteristics				
Household Size (Member Number)	0.96	0.96	0.96	0.96
Household Wealth (Ref- Quintile 1)				
Quintile 2	1.50	1.50	1.52	1.52
Quintile 3	1.44	1.40	1.42	1.45
Quintile 4	1.02	1.02	1.03	1.01

Fixed effects	IM1	IM2	IM3	IM4
Quintile 5	1.57	1.54	1.55	1.56
Community Wealth	1.32**	1.31*	1.31*	1.32**
Community average age of children (Months)	1.04*	1.04*	1.04*	1.04*
Community average mothers' education	0.70	0.70	0.72	0.70
Community average of immunization knowledge	1.13	1.17	1.12	1.14
Presence of active VHSNC (Ref- No)				
Yes	1.66*	1.82**	1.66*	1.66*
Interaction Terms				
Mother's: individual organizational participation × community organizational participation	0.93			
Mother's: individual social cohesion × community social cohesion	0.99			
Mother's community-level social cohesion × Mother's information source for Immunization		0.73***		
Mother's individual level organizational participation × Community Wealth			1.23*	
Mother's individual level organizational participation × Presence of active VHSNC				
Mother's individual level organizational participation × Absent of active VHSNC				
Mother's individual level organizational participation × Presence of active VHSNC				1.45*

Note: IM1: Cross-level interaction model including cross-level interaction between organizational participation and organizational participation measures
IM2: Model including an interaction term between mother's community-level social cohesion and mother's information source for Immunization
IM3: Model including an interaction term between mother's individual level organizational participation and community wealth
IM4: Model including an interaction term between mother's individual level organizational participation and presence of active VHSNC in the community

Appendix 9 - Description of the explanatory variables used in chapter five (paper three)

Variables	Description	Type
	Personal Factors	
Individual demography		
Age	Self-reported age of the respondents	Continuous with two spline terms: - Age up to 30 years - Age more than 30 years
Gender	Self-reported age of the respondents	Two Categories - Male - Female
Religion	Self-reported religion of the household	Two Categories - Hindu - Muslim and others
Caste	Self-reported social caste of the household	Three Categories - General - ST/SC - OBC and others
Marital Status	Self-reported marital status of the respondent	Three Categories - Never married/Not stated - Married - Widow/Divorced/Separated
Education	Self-reported educational attainment of the respondent	Four Categories - Illiterate - Up to primary (5^{th} grade) - Up to secondary (10^{th} grade) - Above secondary
Occupation	Self-reported occupation of the respondent	Six Categories - Cultivator - Wage laborer - Self-employed & Others - Salaried worker - Housewife - Unemployed
Household size	Self-reported number of a household member living in the house for the last six months	Continuous with three spline terms: - Up to 3 members

Variables	Description	Type
		- Up to 10 members - More than ten members
Household wealth (assets quintile)	Asset index developed by principal component analysis using 27 binary variables. The variables include information regarding ownership of household assets, house and land ownership. Standardized score of the first component was used to create five asset quintile group.	Five Categories: From Quintile 1 to 5
Individual personality traits		
Freedom of making decisions	Derived from the question: "How much freedom do you have in making personal decisions?". Two separate categories were developed from the original responses: 1. Low = "No freedom at all", "Freedom in very few decisions" and "Freedom in some decisions." 2. High = "Freedom in most decisions" and "Freedom in all decisions"	Two Categories - Low - High
Perceived Power	Derived from the question: "Do you feel that you can improve things in your community if you want to?". Three separate categories were developed from the original responses: 1. Low = "No, not at all" 2. Medium = "Yes, but with a great deal of difficulty" and "Yes, but with a little difficulty" 3. High = "Yes, fairly easily" and "Yes, very easily"	Three Categories - Low - Medium - High
Satisfaction with material circumstances	Tertile developed from the first component of the principal component analysis using 19 binary variables related to household head's satisfaction towards minimum needs in the following areas: daily food, meals in holidays, clothing, shoes, accommodation, water, electricity, furniture, personal hygiene products, transportation, education etc.	Three Categories - Low - Medium - High
Level of happiness	Derived from the question: "Taking all things together, would you say you are happy, unhappy or neither?". Three separate categories were developed from the original responses: 1. Unhappy = "Very unhappy" and "Somewhat unhappy" 2. Neither happy nor unhappy = Neither happy nor unhappy 3. Happy = "Somewhat happy" and "Very happy"	Three Categories - Unhappy - Neither happy nor unhappy - Happy
Perceived accessibility	Perceived accessibility was measured by household head's self-reported perception of improvement of village infrastructure service: "How has the functioning of infrastructure in your village (e.g., roads, electricity, and water supply) changed since last year?"	3 Categories - Improved - Stayed the same - Worsened

Variables	Description	Type
	Social Capital	
Individual Level Social Capital		
12 modified item of Adapted Social Capital Assessment Tool (SASCAT)[1,2] reported by 6,218 household heads were used to perform a multilevel Confirmatory factor analysis (MCFA). Four uniquely identified factor emerged from the MCFA model at both individual and the community (PSU level)		
Individual organizational participation	Standardized factor score derived from the MCFA model with three indicators: 1. Group Membership = In the last 12 months, participated in or received any benefit from any community group 2. Collective Action = In the last 12 months, worked together with other community members and attempted to address a problem or common issue of the village 3. Development Discussion = In the past 12 months, spoke with anyone about the development of the village	Binary - Yes - No
Individual social support	Standardized factor score derived from the MCFA model with three indicators: 4. Emotional Support = In the last 12 months, received any emotional social support 5. Financial Support = In the last 12 months, received any financial social support 6. Informational Support = In the last 12 months, received any informational social support	Binary - Yes - No
Individual trust	Standardized factor score derived from the MCFA model with two indicators: 7. Trust in Leaders = Overall, trust in village leaders 8. Trust in Strangers = Overall, trust in unfamiliar people residing in the village 9. Trust in Neighbors = Overall, trust in village neighbors	3 Categories - No - Sometimes - Yes
Individual social cohesion	Standardized factor score derived from the MCFA model with four indicators: 10. Social Harmony = People in this village generally have good relationships with each other 11. Sense of Belonging = Feel that you belong to this village 12. Sense of Fairness = People in this village would try to take advantage of you if they get the chance	3 Categories - No - Sometimes - Yes
Community Level Social Capital		
Community organizational participation	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Community social support	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Community trust	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous
Community social cohesion	PSU level standardized factor score derived from level 2 of Multilevel MCFA	Continuous

Variables	Description	Type
	Social Environment	
Community demography		
Gram Panchayat Size	Tertile developed based on the population of the gram panchayat reported from 2011 Census of India[3]	3 Categories - Small - Medium Large
Community wealth	Average scores of the first component of principal component analysis from the households of each cluster. The score is standardized for easier interpretation	Continuous
Community Health service function	Average cluster score of individual's perceptions on the improvement of community health services	Continuous
Community tobacco consumption	Scaled no-self cluster proportion of tobacco use was generated by calculating the proportion of the household heads in the community (PSU) who consumed tobacco while excluding the respondent both from the numerator and denominator and then multiplying the proportion by 10. One unit increase in of this scaled indicator represents a 10% increase in "Non-self" cluster proportion of Tobacco use	Continuous

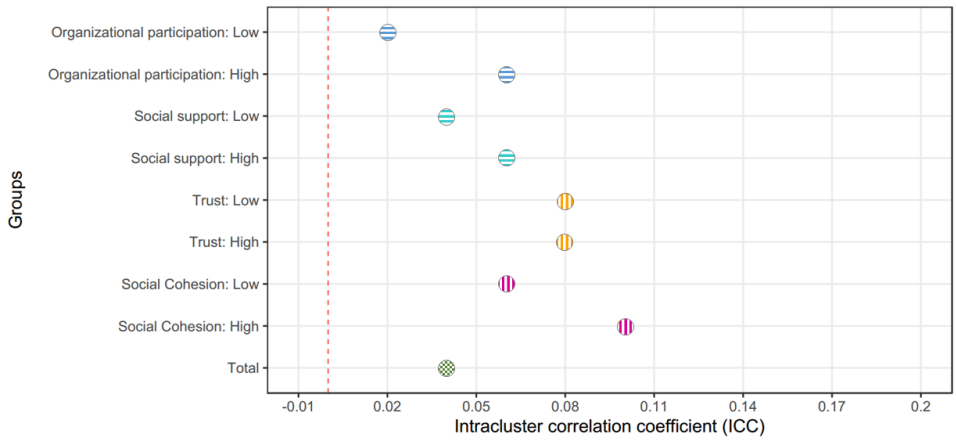
Note: ST/SC = Scheduled castes and scheduled tribes, OBC = Other backward castes, MCFA= Multilevel confirmatory factor analysis

1 = Story WT, Taleb F, Ahasan SM, Ali NA. Validating the Measurement of Social Capital in Bangladesh A Cognitive Approach. Qualitative health research. 2015;25(6):806–819.

2 = De Silva MJ, Harpham T, Tuan T, Bartolini R, Penny ME, Huttly SR. Psychometric and cognitive validation of a social capital measurement tool in Peru and Vietnam. Social Science & Medicine. 2006 Feb;62(4):941–53.

3 = Office of the Registrar General & Census Commissioner. States Census 2011 [Internet]. 2011 [cited 2017 Dec 13]. Available from: http://www.census2011.co.in/states.php

Appendix 10 – Intracluster correlation (ICC) of individual tobacco consumption for high (Q5) and low (Q1) quintile group of individual social capital

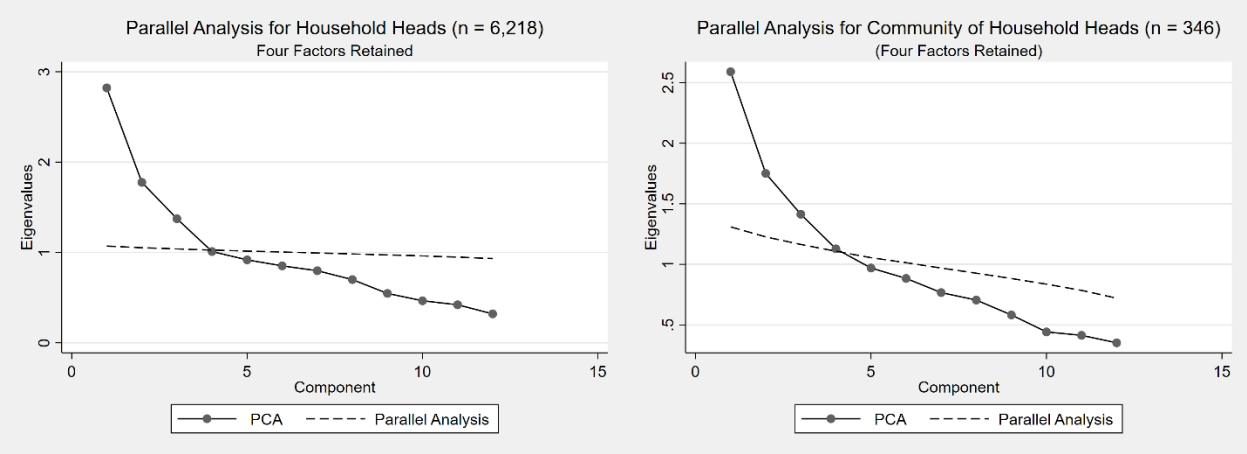


Note: ICC of tobacco use was calculated using postestimation after running a logistic random-effects model considering PSU as cluster.

Appendix 11 – Multilevel confirmatory factor analysis to generate social capital measures for household heads used in chapter five (paper three)

Adapted from original SASCAT (De Silva et al., 2006) and SASCAT-B (Story et al., 2015b) using rapid cognitive interviewing, the modified-SASCAT is a self-reported measure of social. The study sample household heads from 6,218 randomly selected households who responded to the modified-SASCAT during a community-level multistage cross-sectional survey. To assess the factor structure of social capital, 12 binary items were generated from 13 self-reported questions of modified SASCAT. The first seven questions of the tool are related to structural social capital - Group membership (2 questions), Collective action (2 questions), Social support (3 questions). The last six questions are related to cognitive social capital- Trust (3 questions) and Social Cohesion (3 questions). Four unique factors were identified both at the level of individual household head and at the community (PSU) level during Horn's (1965) parallel analysis.

Figure: Scree plots indicating the possible number of factors identified at individual and community level for household heads using modified-SASCAT

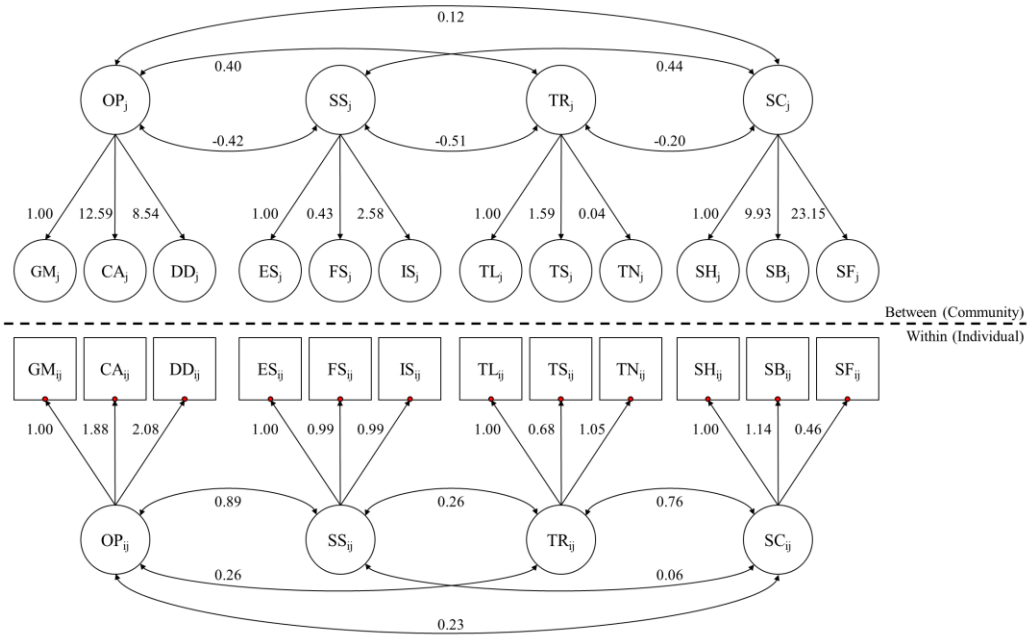


Note: Figures illustrates the expected eigenvalues (the solid line) and parallel analysis (the dotted line). PCA = Principal Components Analysis

Next, the factor structure of household head's social capital was identified through multi-level exploratory factor analysis using "Weighted Least Square Mean and Variance" (WLSMV) adjusted estimator using polychoric correlation matrix and holding factor variances fixed to one. To assess the construct validity of

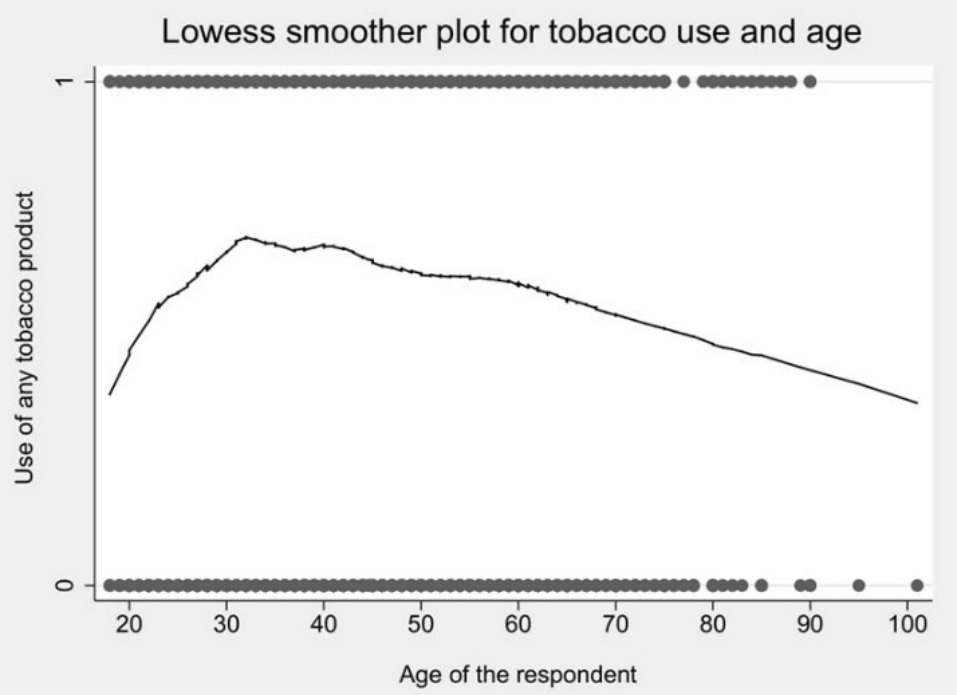
the social capital factor structure and to generate standardized factor score of each construct of social capital we conducted a multilevel confirmatory factor analysis (MCFA) which resulted "Maximum Likelihood Robust" estimator using polychoric correlation matrix and holding factor variances fixed to one. The model presented an adequate fit with the data with RMSEA= 0.32, CFI = 0.91, TLI = 0.88, SRMR = 0.05, $\chi 2$ value= 715.32, df= 96, $p<0.01$. Figure 2 presents the path diagram of MCFA with unstandardized factor loadings and inter-factor correlations. Associated factor scores of the eight social capital constructs were extracted from the MCFA and used in the regression models to assess the relationship between each construct of social capital and tobacco use.

Figure: Path diagrams presenting unstandardized factor loadings and inter-factor correlations of four-factor multilevel CFA model for household heads in rural Uttar Pradesh (n = 6,218)



Note: *Factors: OP= Organizational participation, SS = Social Support, TR = Trust, SC = Social Cohesion*
Goodness of fit Indices (of the same model estimated by WLSMV): RMSEA= 0.32, CFI = 0.91, TLI = 0.88, SRMR = 0.05,
$\chi 2$ value= 715.32, df= 96, $p<0.01$
GM = Group Membership, CA = Collective Action, DD = Development Discussion, ES = Emotional Support, FS = Financial Support, IS = Informational Support, TS = Trust in Leaders,
TS = Trust in Strangers, TS = Trust in Neighbors, SH = Social Harmony, SB = Sense of Belonging, SF = Sense of Fairness

Appendix 12 – Locally weighted scatterplot smoothing (Lowess) plots for tobacco use vs. age of household heads in rural Uttar Pradesh, India (n = 6,218) used in chapter five (paper three)



Appendix 13 – Regression diagnostics of model used in chapter five (paper three)

In this study, we have developed several regression models to explore the adjusted association of social capital and social influence on tobacco use. The models are as follows: To perform the regression diagnostics and goodness of fit we have performed a wide range of regression diagnostics. Description and result of those tests are presented below.

A. AIC (Akaike information criterion) and BIC (Bayesian information criterion)

Based on the AIC and BIC Model 6 presented the best goodness of fit:

Models	AIC	BIC
Adjusted model	6921.3	6891.4
Adjusted model with interactions	7183.9	7221.4

B. Hosmer-Lemeshow goodness-of-fit test:

Hosmer-Lemeshow goodness-of-fit test for both models with and without interaction presented a non-significant p-value indicating this model had an adequate fit to the data.

```
Logistic model for Adjusted model, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 | Exp_1 | Obs_0 | Exp_0 | Total |
  |-------+--------+-------+-------+-------+-------+-------|
  |     1 | 0.1689 |    81 |  72.8 |   540 | 548.2 |   621 |
  |     2 | 0.4979 |   192 | 203.5 |   429 | 417.5 |   621 |
  |     3 | 0.6125 |   344 | 349.4 |   277 | 271.6 |   621 |
  |     4 | 0.6716 |   396 | 400.2 |   225 | 220.8 |   621 |
  |     5 | 0.7081 |   427 | 428.9 |   194 | 192.1 |   621 |
  |-------+--------+-------+-------+-------+-------+-------|
  |     6 | 0.7380 |   444 | 449.6 |   177 | 171.4 |   621 |
  |     7 | 0.7639 |   475 | 466.8 |   146 | 154.2 |   621 |
  |     8 | 0.7901 |   491 | 482.3 |   130 | 138.7 |   621 |
  |     9 | 0.8208 |   499 | 500.0 |   122 | 121.0 |   621 |
  |    10 | 0.9006 |   529 | 524.4 |    92 |  96.6 |   621 |
  +--------------------------------------------------------+

       number of observations =      6210
             number of groups =        10
     Hosmer-Lemeshow chi2(8) =         4.17
                Prob > chi2 =         0.8415
```

```
. lfit, all group(10) table

Logistic model for Adjsuted model with interaction, goodness-of-fit test

  (Table collapsed on quantiles of estimated probabilities)
  +--------------------------------------------------------+
  | Group |   Prob | Obs_1 | Exp_1 | Obs_0 | Exp_0 | Total |
  |-------+--------+-------+-------+-------+-------+-------|
  |     1 | 0.1555 |    65 |  65.8 |   556 | 555.2 |   621 |
  |     2 | 0.4887 |   205 | 206.3 |   416 | 414.7 |   621 |
  |     3 | 0.6043 |   344 | 344.2 |   277 | 276.8 |   621 |
  |     4 | 0.6676 |   405 | 396.8 |   216 | 224.2 |   621 |
  |     5 | 0.7086 |   415 | 427.5 |   206 | 193.5 |   621 |
  |-------+--------+-------+-------+-------+-------+-------|
  |     6 | 0.7406 |   457 | 449.9 |   164 | 171.1 |   621 |
  |     7 | 0.7685 |   470 | 468.4 |   151 | 152.6 |   621 |
  |     8 | 0.7962 |   488 | 485.4 |   133 | 135.6 |   621 |
  |     9 | 0.8286 |   501 | 504.3 |   120 | 116.7 |   621 |
  |    10 | 0.9054 |   528 | 529.3 |    93 |  91.7 |   621 |
  +--------------------------------------------------------+

      number of observations =      6210
            number of groups =        10
    Hosmer-Lemeshow chi2(8) =         2.30
                Prob > chi2 =         0.9706
```

C. Variation inflation factor (VIF):

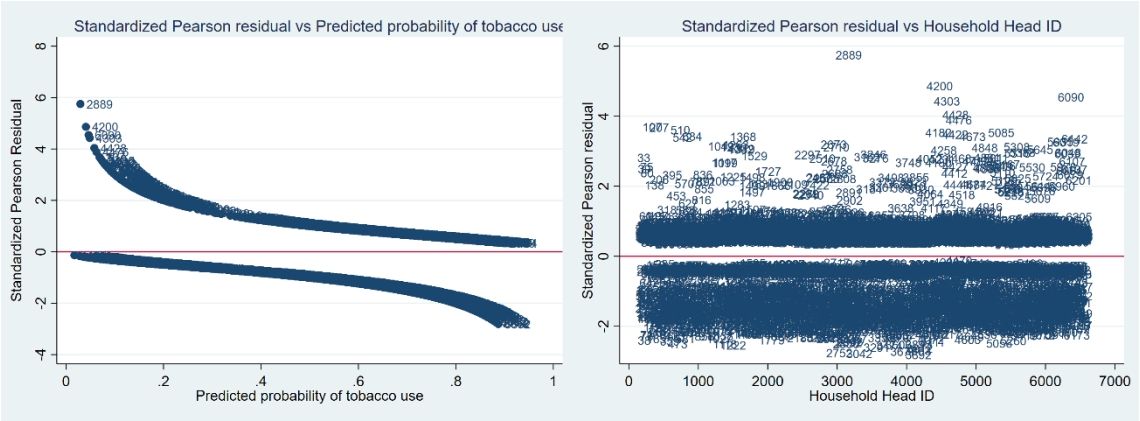
The covariate pattern of the adjusted model presented VIF < 10

Variable	VIF	1/VIF
Gender (Ref-Men)	3.34	0.299576
Women		
Age up to 30	1.32	0.75643
Age above 30	1.54	0.648943
Marital Status (Ref- Widow/Separated)		
Never married/Not stated	1.42	0.705533
Married	1.58	0.633159
Religion (Ref- Hindu)		
Muslim and others	1.18	0.848058
Caste (Ref- General)		
ST/SC	2.32	0.431367
OBC and others	2.09	0.478543
Education (Ref-Illiterate)		
Up to primary	1.35	0.740733
Secondary	1.58	0.633716
Above secondary	1.44	0.693638
Occupation (Ref- Cultivator)		
Wage laborer	1.34	0.746622
Self-employed & Others	1.15	0.869154
Salaried worker	1.11	0.901668
Housewife	3.23	0.309228

Unemployed	1.2	0.831947
Assets quintile (Ref- Quintile 5)		
Quintile 1	2.41	0.415249
Quintile 2	2.15	0.464587
Quintile 3	1.95	0.51342
Quintile 4	1.73	0.577365
Household Size (Ref- Small: up to 5 Member)		
Large (>5 Members)	1.09	0.918221
Freedom decision making (Ref- Low)		
High	1.05	0.951135
Perceived Power (Ref-low)		
Medium	1.1	0.908644
High	1.09	0.916183
Material satisfaction (Ref- Low)		
Medium	1.53	0.655549
High	1.85	0.539754
Level of happiness (Ref- Unhappy)		
Neither happy nor unhappy	1.61	0.62128
Happy	1.89	0.527903
Perceived accessibility (Ref- infrastructure worsened)		
Stayed the same	1.91	0.52278
Improved	1.96	0.510711
Individual Organizational participation	1.25	0.803084
Community Social support	2.45	0.407408
Community Social cohesion	2.07	0.483797
Gram panchayat size (Ref- Small)		
Medium	1.38	0.726889
Large	1.39	0.721608
Community wealth	1.3	0.771844
PSU health service function improvement	1.25	0.79683
Social Influence	1.12	0.892122
Mean VIF	1.65	

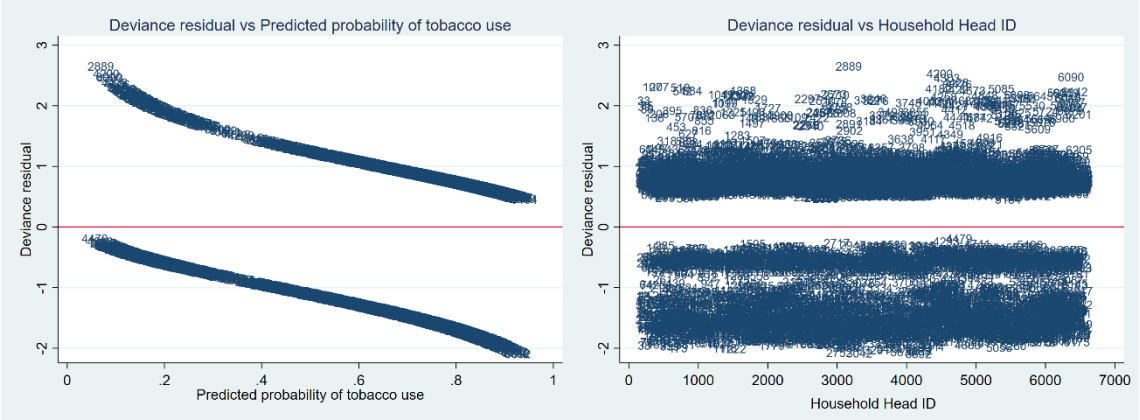
D. Examining residual and predicted values

a. Standardized Pearson residual:



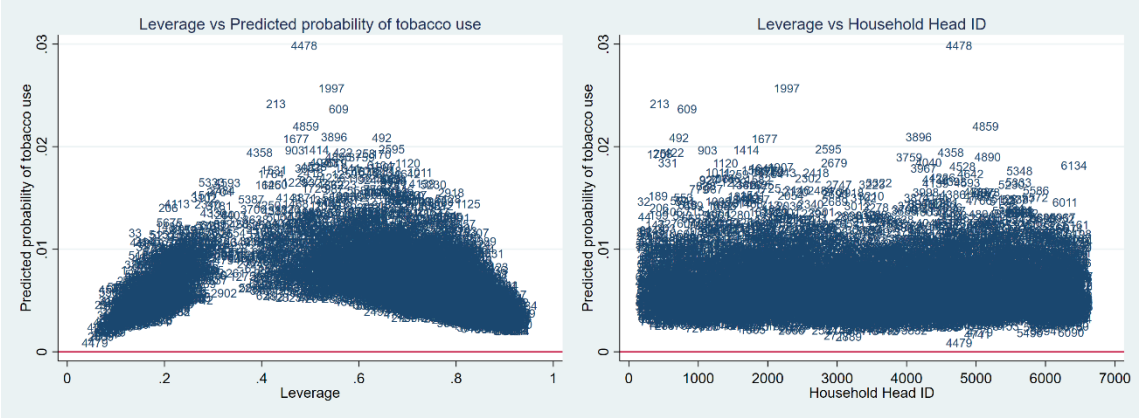
Observation 2889, 4200, 4303 and 6090 presented comparatively higher residuals

b. Deviance residual:



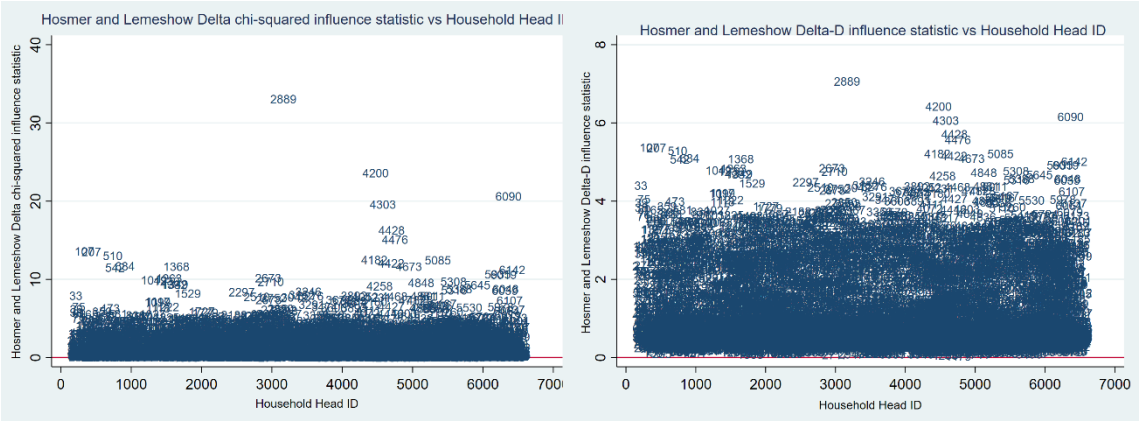
Observation 2889 presented comparatively higher residuals

c. Leverage:



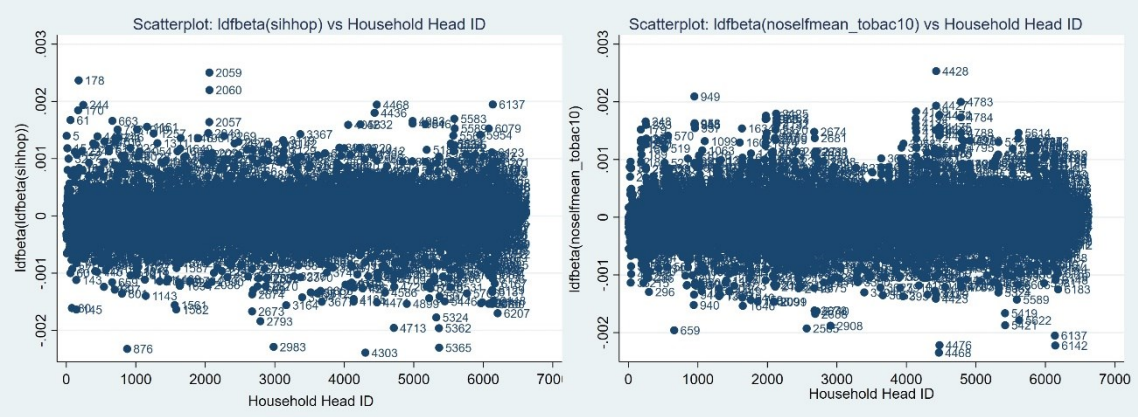
Observation 4478, 1997, 213 and 609 presented comparatively higher leverage

d. Hosmer and Lemeshow Delta chi-squared and Delta-D influence statistic:

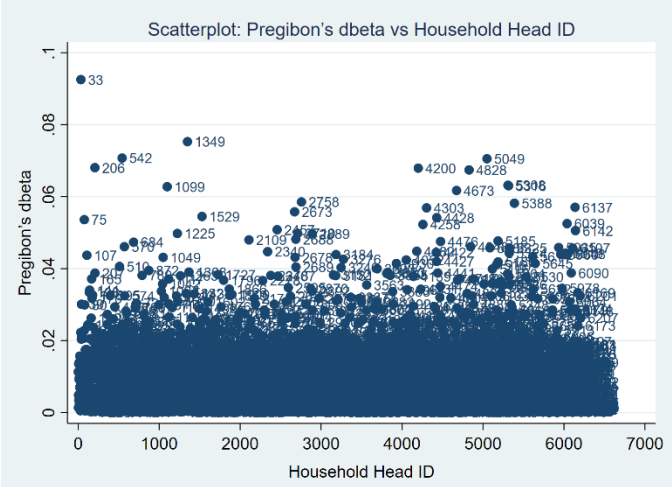


Observation 2889, 4303, 4200, 6090 presented comparatively higher influence

e. Coefficient sensitivity assessment using DF-BETA



f. Pregibon's dbeta



Observation 1349, 33 presented comparatively higher influence

Appendix 14 – Sensitivity Analysis by removing observations with high influence and leverage of the final model used in chapter five (paper three)

Explanatory Variables	(1) Adjusted Model	(2) Removing 25 high influence and leverage observation
Gender (Ref- Men)		
Women	0.07***	0.06***
Age up to 30 years	1.08***	1.09***
Age above 30 years	0.98***	0.98***
Marital Status (Ref- Widow/Separated)		
Never married/Not stated	0.95	0.93
Married	1.07	1.04
Religion (Ref- Hindu)		
Muslim and others	1.14	1.14
Caste (Ref- General)		
ST/SC	1.06	1.09
OBC and others	1.05	1.07
Education (Ref-Illiterate)		
Up to primary	0.84*	0.83*
Secondary	0.60***	0.59***
Above secondary	0.31***	0.30***
Occupation (Ref- Cultivator)		
Wage laborer	0.93	0.93
Self-employed & Others	0.97	0.97
Salaried worker	0.82	0.79
Housewife	0.70	0.73
Unemployed	0.82	0.82
Assets quintile (Ref- Quintile 5)		
Quintile 1	1.20	1.16
Quintile 2	1.12	1.11
Quintile 3	1.14	1.13
Quintile 4	1.07	1.06
Household Size (Ref- Small: up to 5 Member)		
Large (>5 Members)	1.07	1.06
Freedom decision making (Ref- Low)		
High	1.16	1.15
Perceived Power (Ref-low)		
Medium	1.09	1.10
High	1.35**	1.40**
Material satisfaction (Ref- Low)		
Medium	0.98	0.98
High	0.91	0.92
Level of happiness (Ref- Unhappy)		
Neither happy nor unhappy	0.84*	0.84*
Happy	0.88	0.87
Perceived accessibility (Ref- infrastructure worsened)		
Stayed the same	1.51***	1.54***
Improved	1.60***	1.63***
Individual Organizational participation	1.06*	1.07*

Explanatory Variables	(1) Adjusted Model	(2) Removing 25 high influence and leverage observation
Community Social support	1.07	1.09*
Community Social cohesion	0.98	0.97
Gram panchayat size (Ref- Small)		
Medium	0.93	0.91
Large	1.01	1.02
Community wealth	0.98	0.98
PSU health service function improvement	0.96	0.95
Social Influence	1.10***	1.11***
Observations	6210	6185

Note: *** = p < 0.001, ** = p < 0.01, * = p< 0.05

Appendix 15 – Stratified regression analysis across the gender of the final model used in chapter five (paper three)

Explanatory Variables	Without stratification	Male	Female
Age up to 30 years	1.08***	1.08***	1.03
Age above 30 years	0.98***	0.98***	1.02
Gender (Ref- Men)			
Women	0.07***		
Religion (Ref- Hindu)			
Muslim and others	1.14	1.00	2.47**
Caste (Ref- General)			
ST/SC	1.06	1.12	0.49**
OBC and others	1.05	1.08	0.75
Marital Status (Ref- Widow/Separated)			
Never married/Not stated	0.98	0.94	1.54
Married	1.04	1.06	1.02
Education (Ref-Illiterate)			
Up to primary	0.84*	0.79**	0.97
Secondary	0.61***	0.55***	2.20*
Above secondary	0.31***	0.29***	0.75
Occupation (Ref- Cultivator)			
Wage laborer	0.93	0.91	2.32
Self-employed & Others	0.98	0.98	1.95
Salaried worker	0.83	0.79	1.97
Housewife	0.70	NA	1.19
Unemployed	0.82	0.83	1.21
Household member up to 3 persons	1.08	1.08	1.06
Household member 3 to 10 persons	1.03	1.02	1.17*
Household member above 10 persons	0.90	0.94	NA
Assets quintile (Ref- Quintile 5)			
Quintile 1	1.21	1.17	1.78
Quintile 2	1.13	1.11	1.28
Quintile 3	1.14	1.17	0.93
Quintile 4	1.07	1.12	0.70
Freedom decision making (Ref- Low)			
High	1.15	1.19	0.79
Perceived Power (Ref-low)			
Medium	1.10	1.06	1.80*
High	1.36**	1.37*	1.58
Material satisfaction (Ref- Low)			
Medium	0.97	1.02	0.55*
High	0.91	0.94	0.70
Level of happiness (Ref- Unhappy)			
Neither happy nor unhappy	0.82*	0.77**	1.34
Happy	0.86	0.80*	1.62
Quality of life	1.01	1.01	1.02
Perceived financial stability (Ref- High)			
Low	1.07	1.04	1.81
Medium	1.20	1.15	2.07
Perceived accessibility (Ref- infrastructure worsened)			
Stayed the same	1.47***	1.57***	0.79
Improved	1.57***	1.66***	0.89

Individual Organizational Participation	1.07*	1.05	1.25*
Community Social Support	1.08	1.08	1.16
Community Social Cohesion	0.98	0.97	1.21
Gram panchayat size (Ref- Small)			
Medium	0.93	0.89	1.25
Large	1.01	1.03	0.92
Community wealth	0.99	0.98	1.02
PSU health service function improvement	0.96	0.93	1.04
Social Influence	1.10***	1.12***	0.98
Observations	6210	5305	895
Note: *** = p < 0.001, ** = p < 0.01, * = p< 0.05			

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Evaluation of International Health Programs, 2018

WORK EXPERIENCE

Primary Health Care Performance Initiative (PHCPI), The World Bank, Washington DC, USA
Consultant: Data Analyst- Country Measurement and Analytics (September 2018 – current)

Department of International Health, Johns Hopkins Bloomberg School of Public Health, Maryland, USA
Graduate Research Assistant, (October 2016 – current)

James P. Grant School of Public Health, BRAC University, Dhaka, Bangladesh
Research Associate (2014 – 2015), Senior Research Associate (February 2015 – July 2015)

Shaheed Suhrawardy Medical College, University of Dhaka, Dhaka, Bangladesh
Intern Medical Officer (2011 – 2012)

RESEARCH EXPERIENCE

World Bank Group, Washington, DC
Primary Health Care Performance Initiative (PHCPI), Data Analyst
September 2018 – current

- Providing analytical and development Country Vital Signs Profiles and Country chartbooks for primary health care systems for low and middle-income countries
- In collaboration with researchers from the World Bank and WHO, interpreting and operationalizing the primary health care performance scorecard
- Advocacy and knowledge management of county partners accelerate frontline service delivery for health system strengthening in LMIC

Johns Hopkins Bloomberg School of Public Health, Maryland, USA
Implementation of a Model District in Sitapur, Uttar Pradesh, India, Graduate Research Assistant
September 2018 – current

- Collaboratively developing the proposal for "model health district" implementation plan in Sitapur, Uttar Pradesh with the University of Manitoba and Uttar Pradesh Technical Support Unit (UP-TSU) funded by Bill & Melinda Gates Foundation
- Providing technical and methodological support to Uttar Pradesh Technical Support Unit (UP-TSU) to develop primacy health facility strengthening and community empowerment interventions
- Developing an evaluation framework, measurement indicators and tools related to health service delivery, supply chain management, human resource performance, and quality control

Baseline Evaluation of Project Samuday in Uttar Pradesh, India, Student Investigator
November 2016 – January 2018

- Supervised facility assessment and health worker survey in 66 government health facilities and community health workers from 346 villages collaborating with Ministry of Health, Ministry of Women and Child Development and HCL Foundation as a part of the baseline evaluation of Project Samuday
- Developed and implemented a quality assurance framework which resulted in <8% error rate in the collected data and marked performance improvement of data collectors in the baseline survey
- Conducted econometric analysis, thematic analysis, compiled final evaluation report and presented result in dissemination workshop
- Conducted in-depth interviews and focus groups discussion to understand the collaborative environment and responsiveness of government health services amongst the marginalized population in 12 villages of Hardoi District of Uttar Pradesh India

Measuring Impact: Technical Assistance for Telenor Health in Bangladesh, Graduate Research Assistant
May 2016 – January 2017

- Facilitated Telenor Health to develop impact model for measuring key health outcomes for their mHealth intervention "Tonic"
- Conducted group model building workshops to generate system level indicators which harmonized Telenor's business model with sustainable development goals
- Developed methodology of micro-trials to assess customer satisfaction and willingness to pay for a micro-insurance to help offset out of pocket costs to customers

James P. Grant School of Public Health, Dhaka, Bangladesh
Understanding the Effect of a Health Security Program in Advocating Universal Health Coverage and Improving Productivity of Semi-Formal Female Workers in Bangladesh, Senior Research Associate
March 2015 – June 2015

- Developed proposal for a randomized control trial for rural semi-formal female workers in Bangladesh in collaboration with BRAC and Ayesha Abed Foundation funded by Rockefeller Foundation, USA through Centre of Excellence for Universal Health Coverage

Evaluation of BRAC Health Security Programme, Senior Research Associate
August 2014 – June 2015

- Developed proposal to evaluate "BRAC Health Security Program" (BHSP), a community-based health insurance project which received funding from Rockefeller Foundation, USA through Centre of Excellence for Universal Health Coverage
- Implementation of a mixed method evaluation of the BHSP coordinating with multiple division of BRAC, including health, population, and nutrition division, microfinance division and BRAC education
- Managed $15,000 project budget, allocating funds efficiently to support four months field-based data collection, analysis, and dissemination
- Conducted econometric analysis, compiled final evaluation report and presented result in dissemination workshop

Clinical evaluation of dengue and identification of risks factors for severe disease in Bangladesh, Research Associate
February 2014 – August 2015

- Coordinated with "International Research Consortium on Dengue" for implementation of the clinical site in a tertiary medical college hospital at Dhaka, Bangladesh as the Country Research Coordinator funded by European Commission
- Managed $65,000 project budget allocating funds efficiently to manage the data collection site, project procurement and reimbursement of the patients

- Supervised clinical data collection and quality control process collaborating with the international clinical monitor from the University of Heidelberg

TEACHING EXPERIENCE

Johns Hopkins Bloomberg School of Public Health, Maryland, USA
Teaching Assistant

- Systems Thinking in Public Health: Applications of Key Methods and Approaches
- Organizing for Public Health: a Systems Approach
- Foundations of International Health
- Health Systems in Low and Middle-Income Countries
- Introduction to International Health

James P. Grant School of Public Health, Dhaka, Bangladesh
Teaching Fellow

- Introduction to Public Health
- Quantitative Research Methodology
- Monitoring and Evaluation

Faculty Mentor
Summative Learning Project

- Collaborated on curriculum development and conceptualization of student projects
- Conducted weekly lab practicum, mentored 7 Master of Public Health students for proposal development and manuscript writing

PUBLICATIONS, CONFERENCE PRESENTATIONS AND TECHNICAL REPORTS

Peer-Reviewed Journal Articles

Al Kibria, G. M., Swasey, K., **Hasan, M. Z.**, Choudhury, A., Gupta, R. D., Abariga, S. A., ... & Burrowes, V. (2018). Determinants of hypertension among adults in Bangladesh as per the Joint National Committee 7 and 2017 American College of Cardiology/American Hypertension Association hypertension guidelines. Journal of the American Society of Hypertension, 12(11), e45-e55

International Conferences

Hasan, M. Z., Bishai, D., Rao, K. D., Ahuja, A., Gupta, S. Does social capital help households to pay for health? Evidence from rural Uttar Pradesh, India. Paper Presentation. World Congress of Health Economics, Basel Switzerland, July 13-17, 2019

Hasan, M. Z., Cohen, J. E., Bishai, D., Ahuja, A., Gupta, S. Role of social capital and social influence on tobacco consumption among household heads in rural Uttar Pradesh, India. World Congress of Health Economics, Basel Switzerland, July 13-17, 2019

Hasan, M. Z., Mohan, D., Ahuja, A., Gupta, S. *Does Health Worker Motivation and Satisfaction Affect Patient Satisfaction in Rural UP, India?* Poster Presentation. Annual Consortium of Universities for Global Health Conference: Chicago, IL. March 8, 2019

Hasan, M. Z., Gayen, P., Chowdhury, I. A., Islam, M. T., Sarker, M. *Mobilizing Community for Participating in Community Based Health Financing: A Qualitative Study Exploring Experiences of Female Community Health Workers of BRAC.* Paper session. World Congress of Health Economics, University of Boston, MA, July 17, 2017

Hasan, M. Z., Nazneen, S., Rasul, F. B., Adib, H. I., Sarker, M. *Pitfall of Health Seeking: Catastrophic Health Expenditure and it's Determinants in Bangladesh, Prince Mahidol Award Conference.* Poster Presentation. Prince Mahidol Award Conference, Bangkok, Thailand, February 2, 2016

Hasan, M. Z., Gayen, P., Chowdhury, I. A., Islam, M. T., Sarker, M. *Building Trust on a Voluntary Community-Based Health Financing Program for Social Inclusion: Case Analysis of BRAC Health Security Program.* Prince Mahidol Award Conference, Bangkok, Thailand, February, 2017

International Conferences Panelist

Health & Public Policy Panelist: The Changing Health Landscape of Asia- Solutions for the Future. Harvard Project for Asian & International Relations: Asia's Blueprint for the Future: Building Inclusive Growth. Harvard University, Cambridge, Massachusetts, USA, February, 2015

Panelist: Bringing the context of uncertainty into the teaching and learning environment, FHS' 60th Anniversary International Scientific Conference: Public Health in Contexts of Uncertainty, American University of Beirut, Beirut, Lebanon, December 2014

Technical Reports

Hasan, M. Z., Adams, A., Sarker, M., 2014, *Availability, accessibility, utilization, and adequate coverage of human resources for health.* The Indicators Challenge (iChallenge), World Bank: https://consultations.worldbank.org/content/indicator-availability-accessibility-utilization-and-adequate-coverage-health-human

PEER REVIEWER

- PlosOne
- Journal for "Global Health Action"
- International Journal for Equity in Health

RESEARCH SKILLS

- Statistical software: STATA, R, MPLUS
- Qualitative data analysis software: Atlas.ti, Dedoose
- System modeling software: Vensim, NetLogo, TreeAge

OTHER

- Language: Bangla (native), English (Professional), Hindi (Fluent), Arabic (Intermediate)
- Country experience in Bangladesh, India, United States

PERSONAL DETAILS

Born January 1, 1989 in Dinajpur, Bangladesh
Citizen of Bangladesh